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C. N. G. A. Annual Fall Technical Meeting

President's Address

C. N. G. A.
Fall, 1941

By Walter C. Dayhuff

Mr. Chairman, members and guests: As we meet here today for the 16th yearly Fall Technical Meeting of the California Natural Gasoline Association, it is my very great pleasure to extend a most cordial welcome to several groups.

First, it is a pleasure to welcome back that loyal group of members whose number has increased so greatly through the years. You, through your loyalty, your participation and support, are the mainstay of C.N.G.A. It is a fundamental fact that the value of any technical association of the industry it represents is only as great as the active interest and participation of its members in the work that association seeks to accomplish. That C.N.G.A., as an association, commands a wide interest and prestige because of the many valuable contributions our Association has made to the natural gasoline industry at large, is the harvest of your planting.

Secondly, I have the pleasure of saying a word of welcome to many new C.N.G.A. members who are attending a Fall Meeting in that capacity for the first time. We are happy to have you with us. It is your privilege to receive all the benefits and the fruits of all the labors that have accrued since that day sixteen years ago when a handful of men conceived and organized the Association of which you are now members. You also receive a responsibility, for much remains to be done, and we look to you for help and assistance in the future.

The Natural Gasoline Association of America is represented here today by a large delegation and, under its sponsorship, we are to have a very fine paper presented by two of its members. On behalf of our entire membership, I bid you welcome. This Spring, when N.G.A.A. held its Annual Meeting in Dallas, Texas, C.N.G.A. was represented by a delegation, and each of our members in that delegation benefitted by attending. Moreover, we greatly appreciated the honor that was bestowed upon one of our members at your meeting. I have in mind the Hanlon award which was bestowed upon our Alois Kremser. This is a matter which will be recalled later today.

Many delegates to the American Petroleum Institute Convention, which convenes next Monday morning in San Francisco, have accepted our invitation to stop over in Los Angeles on their way to our sister city in the north and attend our Fall Meeting. We are happy to have you participate with us in this meeting, and I trust that the benefit you will receive will be such that we will not have

Speakers at annual fall meeting of California Natural Gasoline Association. Left to right: Dr. Harold Washburn, Consolidated Engineering Corp.; P. C. Dixon, Foran, Boatright & Dixon; Dr. B. H. Sage, Calif. Institute of Technology; Paul M. Raigorodsky, Ass't. Director of Production, in Charge of Natural Gas Section, Office of Petroleum Coordinator for National Defense; Herbert Hoover, Jr., Consolidated Engineering Corp.; T. A. Dunlap, Standard Oil Co. of Calif.; W. B. Parks, The Norwalk Co.; Dr. E. R. Smoley, The Lummus Co.; Dr. W. N. Lacey, Calif. Institute of Technology; Geo. P. Bunn, Phillips Petroleum Co.; J. E. Laurance, Standard Oil Co. of Calif.

Fall Meeting Committee, California Natural Gasoline Association. Left to right: A. E. Wetzel, Natural Gas Equipment, Inc.; W. W. Robinson, The Texas Co.; J. B. Taylor, Signal Oil & Gas Co.; M. W. Kibre, Chairman, General Petroleum Corp.; D. E. McFaddin, Union Oil Co. of Calif.; H. A. Dresser, The Fluor Corp., Ltd., J. H. Kunkel, public relations counsel.

to wait until California again is host to A.P.I. before you next meet with us.

Modern industry has become so complex that, by the very nature of things, it is often difficult to find a clear line of demarcation separating one branch of an industry from another. So it is that we of C.N.G.A. always have the privilege of welcoming a large number of guests to our Fall Meetings whose activities and problems are related to ours. Today, as always, we are glad to have these men with us.

Each year it is incumbent upon the President of C.N.G.A. to report concerning the progress made during the year which has passed since our last Fall Meeting, As you know, our fiscal year ends and our administration changes each June. I therefore want to point out that the achievements now to be cited represent the good work accomplished under the leadership and during the administration of my predecessor in office, L. V. Cassaday, and the committee chairman and committee members who so ably served with him.

One of the very important accomplishments of the past twelve months is a move which greatly widens the scope of C.N.G.A. for service. I refer to our action in reducing the dues for active individual memberships from $5.00 per year to $2.50 per year.

One of the principal values of C.N.G.A. is that of education of individuals connected with the natural gasoline industry. We sponsor regular monthly meetings, and the papers presented at these events cover a wide range of subjects dealing with all phases of the industry. Likewise, these papers are published and distributed in permanent form. Thus, members not only have an opportunity to hear each topic presented and discussed, but through such publication a reference library of considerable value may be developed. These meetings also serve as a medium for the training of our men in the presentation of papers and provide a forum for the exchange of ideas.

Such facilities for self-improvement are of value to our industry at large. We therefore believe that the reduction in dues and the increased participation of individuals are in the direction of increased benefit to the industry. How successful this move has been is indicated by the fact that since active individual membership dues were reduced 161 new members have been received, bringing our present membership total to 603. There is evidence that this substantial membership growth will continue.

In addition to furnishing a forum for the presentation of papers, C.N.G.A. has two other very important functions. One of these is the compilation of a monthly gas report which gives the pertinent natural gas, gasoline and liquefied gas production data for our Pacific Coast industry. The other very important function of C.N.G.A. is the preparation of various metering, testing and operating standards required by our industry. In use today are thirteen bulletins giving standards for gas metering and the application of Boyle's Law correction factors, gasoline gauging and metering, gas and gasoline sampling, royalty testing, Reid vapor pressure determinations, specific gravity tests, absorption oil tests, fractional analysis, liquefied petroleum gas tests and grades, and physical constants for the natural gas hydrocarbons.

The progress in standardization work during the past year has already been reviewed by our Technical Chairman, J. B. Taylor. Special mention may be made of the two new bulletins now available, namely, TS-402, "Tentative Standard Procedure for the Determination of the Corrected Hourly Gas Coefficient (C') Used in the Measurement of Natural Gas by Orifice Meter," and TS-411, "Tenta-

California Natural Gasoline Association, Entertainment Committee, Fall Meeting. Left to right: Gordon Greene, Robinson Orifice Fitting Co.; E. L. Bishop, Fluor Corp., Ltd.; Glenn J. Gill, J. B. Gill Corp.; H. A. Dresser, Chairman, Fluor Corp., Ltd.; Ben C. Dumm, The Cooper-Bessemer Corp.; Coles Bason, Ingersoll-Rand Co.

Officers and technical chairmen of California Natural Gasoline Association and Natural Gasoline Association of America, C. N. G. A. Fall Meeting. Left to right: H. H. Beeson, Sabine Valley Gasoline Co., Inc., chairman N.G.A.A. Technical Committee; Geo. L. Tyler, secretary, C.N.G.A.; Ray E. Miller, Hanlon-Buchanan, Inc., president, N.G.A.A.; W. C. Dayhuff, Standard Oil Co. of Calif., president, C.N.G.A.; W. W. Robinson, The Texas Company, vice-president, C.N.G.A.; Wm. F. Lowe, secretary, N.G.A.A.; J. B. Taylor, Signal Oil & Gas Co., chairman C.N.G.A. Technical Committee.

tive Standard Method for the Analysis of Natural Gas and Gasoline by Fractional Distillation." These bulletins give our Pacific Coast industry the most advanced and practical methods available for the measurement and analysis of natural gas. Bulletins on hydrogen sulfide testing methods, compressor horsepower computations and truck gauging will be reported out of their respective sub-committees for approval and publication in the near future. Summaries of the material forming the basis for the truck gauging and compressor horsepower bulletins have been presented this morning in papers delivered by Walter Parks and Tom Dunlap.

For some time there has been an apparent need for a natural gasoline textbook for use in adult education classes. Some time ago, the American Petroleum Institute requested that C.N.G.A. sponsor the preparation of such a work, and this is now under way.

Our Taft C.N.G.A. Chapter under Chairman C. S. Beard and M. M. McMahon has given a good account of itself this past year. Their monthly meetings have been practical and instructive, and attendance has been high. Expanding upon the Taft annual "gadget" program, we held a joint Los Angeles Basin—Taft "gadget" contest at Lebec this year at which our operators and gas men entered 76 useful operating ideas. The N.G.A.A. has held similar affairs for several years, referring to them as "kink" sessions. It has been suggested that plans be worked out to have the prize winners of N.G.A.A. and C.N.G.A. compete for a grand prize next year.

The work of C.N.G.A. is carried on through an administration group composed of the Executive Committee and the general chairmen and the Technical Committee group composed of committees working on various standardization problems. Time does not permit me to detail the work of each committee and name each committee member. However, I believe it appropriate to name the committee chairmen, adding the request that they convey our sincere thanks to all.

W. W. Robinson, Jr., of The Texas Company is Chairman of the Advisory Committee. The Finance and Budget Committee administrating our financial affairs is headed by Tom Taggart, Standard Oil Company of California. Fane H. Krebs of Lomita-Signal-Wilmington Associates heads our Auditing Committee handling the accounting affairs of the Association. Our monthly meeting programs are arranged by the Program Committee of which D. E. McFadden, Union Oil Company of California, is Chairman. H. A. Dresser of The Fluor Corporation, Ltd., heads our Entertainment Committee which caters to the social life of our Association. John H. Kunkel, public relations counsel, is Chairman of our Publicity Committee which keeps our membership and the industry at large acquainted with details of our activities and events. Our Membership Committee is headed by L. L. Bendinger of Lomita Gasoline Company. R. D. Gibbs, Union Oil Company of California, heads our Gas Report Committee which supervises the compilation of gas and gasoline statistics. The Fall Meeting Committee, the results of whose work you will observe today, is under the chairmanship of M. W. Kibre, General Petroleum Corporation. J. B. Taylor, Signal Oil and Gas Company, is Chairman of the C.N.G.A. Technical Committee. I would be remiss if the splendid work of our Secretary, George Tyler, were not mentioned. He keeps our office running smoothly, efficiently and creditably. Also, I wish to mention that

Dan Griffin Speaks for Steel...

★ Below are quoted the remarks of Dan F. Griffin, a steel worker in the Campbell Works of The Youngstown Sheet and Tube Company, made recently at a meeting of a Youngstown, Ohio, civic club. Reflecting the attitude of Youngstown employees, his words should be of interest to the users of Youngstown steel.

"Today, the eyes of the world are turned upon the ever-increasing conflagration in Europe. We realize that our nation has undertaken the gigantic task of transforming a peace-time nation into a nation geared to total national defense.

"The steel mill employee is playing an ever-increasing and more important role in this task; and the American steel man is tops in the industry.

"We know that as much depends upon the skill and devotion of these steel mill employees as on our armed forces on land, sea, and in the air. To a man, the steel mill employees of America appreciate they are among the highest paid workers in the world. Their working conditions are the best.

"The American steel worker has plenty of leisure time to do as he will. He can work in his garden; he can seek any form of entertainment, not only for himself but also for his family. He can study to improve himself, and quite frequently does. He is in no way limited.

"The highest office in our land has been occupied by men of the most humble birth. Freedom in America has never had a price, but its rewards are unlimited. Your steel mill employee knows that he cannot buy freedom—he must think freedom—he must work for freedom.

"We treasure our American way of life as we have it today. We're prepared to go to any lengths to preserve for ourselves and for our children that tranquility, that comfort, that peace, which we have enjoyed in years past.

"We're willing to pay our share in money or labor—yes, we are already lending. We want our boys to serve—they're already being trained for service.

"Our steel workers' creed should be an all-out effort to procure peace for ourselves and for the rest of the world. If we must work harder or longer to produce the steel necessary to insure that peace, then we're ready and anxious to do our bit, for in that way only do we serve.

"The Army needs steel—we'll make it.

"The Navy needs steel—we'll make it.

"The Air Force needs steel—we'll make it.

"The whole world needs steel, and steel workers will make it, for the real steel man is a true American. He will never do or think anything to jeopardize America. He will do everything in his power to preserve America for Americans and Americanism.

"We'll remember, always, that the men of the Army, the men of the Navy, the men of the Air Force, those defending democracy and the men of production are all ONE.

"We're 'Sammies' on guard!

"The U.S. in United States means US."

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our official publication, the California Oil World, accomplishes an important task in preparing our meeting proceedings and papers for release to the entire membership.

Once each year, on this occasion, we try to view the position of our California industry, broadly taking inventory of current trends as a means of getting a glimpse of the future.

The current factor influencing our industry today is the National Defense Program. Already demands have been made and, as the Defense Program unfolds and accelerates its pace, we may expect even greater demands. The natural gasoline industry, and all individuals who are a part thereof, stand ready and willing to meet those demands, and our industry may be counted upon to discharge the full of its duty within the limits of its boundaries.

During the year the Cole's Levee, Del Valle and Raisin City fields have become prominent from the standpoint of increasing wet gas supplies in the State. However, at the present time, due to natural declines and/or curtailment in several fields, particularly at Montebello, Rosecrans, Dominguez and Belridge, the wet gas supply is now only about 900 million cubic feet per day as compared with 970 million cubic feet per day at the same time last year.

The decrease in wet gas supply has occurred in the face of a marked increase in the demand for gas as fuel in domestic as well as industrial markets. Not only do we find industrial consumption rising as a result of geared-up industry meeting the demands of National Defense, but we find a shift in population from rural districts into urban centers as workers pour in to meet industry's demand for labor. This population shift obviously influences the demand for domestic gas. How extensive this shift in population is may be judged from reliable reports that Los Angeles County's population has increased by approximately 140,000 persons since the 1940 census.

As a result of this increased demand, the gas companies have had to draw to a greater extent on dry gas, and the possibility of a shortage in the gas supply this winter has been a matter of current concern. Many industries, anticipating that this possibility may become a reality, have already and now are installing suitable substitute standby plants.

Reflecting the decline in wet gas supply, the daily average production of 21-pound Reid natural gasoline in California for the first seven months in 1941 was 1,455,000 gallons, as compared with a daily average production of 1,462,000 gallons for 1940. Recent figures would no doubt be more in line with the gas figures quoted above. Gasoline stocks, likewise, have declined. According to the United States Bureau of Mines, stock on hand as of August 31, 1941, totaled 2,061,000 barrels, while stocks on hand as of August 31, 1940, were 2,765,000 barrels, representing a decrease of 704,000 barrels, or approximately 25.5%.

The production of liquefied petroleum gases has, on the other hand, increased materially. The daily average production of liquefied petroleum gas for the first seven months of 1941 totaled about 265,000 gallons, while the daily average production for 1940 totaled about 225,000, or the increase in the average daily production was of the order of 40,000 gallons. This increased production is the result of increased consumption, largely brought about by sales of liquefied petroleum gases to army camps, one of which, alone, is expected to consume 30,000 gallons per day this winter.

The diminished supply of wet natural gas which I have mentioned is especially critical in view of the increasing demand for natural gasoline and liquefied gas fractions. This situation, of course, lends greater attraction to the application of recycling operations.

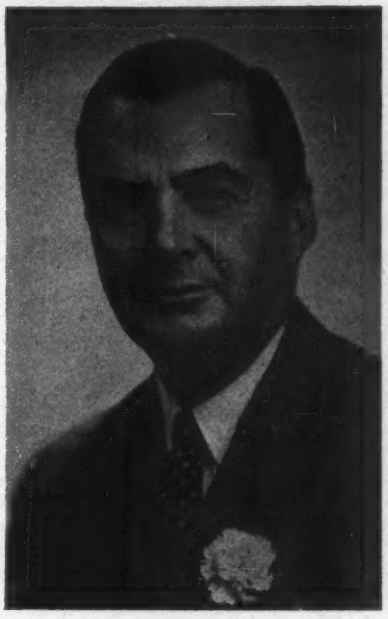
The Government has indicated that the supply of aviation gasoline must be doubled, perhaps trebled, in the very near future. Acting promptly on this matter, the District Five Refining Committee has made a survey of the supplies of isobutane, normal butane and isopentane available in natural gases with a view to effecting their maximum extraction and delivery to aviation gasoline refining centers. While we are extracting a comparatively high percentage of the isobutane at the present time, its extraction must be further increased in many instances. This will call for additional extraction and rectification facilities; also, many transportation problems must be solved.

Our industry has its shoulder to the wheel, and it will cooperate to its utmost with the Government in the solution of these problems. It may be stated also that C.N.G.A.'s function will be an important one in this program. The technical tools which we have built up will be applied in the solution of many immediate problems. Through C.N.G.A. our operators have learned to solve mutual problems on a sound technical basis without friction or misunderstanding. Our Association will continue its efforts to keep our industry in an advanced position so that its responsibilities can be met efficiently and expediently.

Bottled gas—compressed propane or butane beyond the mains—may be used efficiently for "dutch oven" cooking in modern ranges with heavily insulated wells.

George J. O'Brien Now Assistant to S. O. Chief

The board of directors of Standard Oil Co. of California announce the appointment of George J. O'Brien as assistant to the president of the company. Mr.



George J. O'Brien

O'Brien will be the representative of the board of directors in Los Angeles. In assuming this new and important position, Mr. O'Brien relinquishes his duties as treasurer of the corporation.

Mr. O'Brien has spent his whole business life with the Standard Oil Co. He first served during vacation periods, when a student at the University of California, in the Marine and Manufacturing Departments. His first work was as a sailor on the Tanker "J. A. Moffett" in 1916. Thereafter he served in the sales and financial departments. Mr. O'Brien was born in San Diego in 1896. His father was G. N. O'Brien, president of the American National Bank of San Francisco. He was graduated from the University of California in 1919. During the last war he served in the Navy with the rank of Ensign. Mr. O'Brien has had previous company service in Los Angeles in 1924 and 1927. He is widely known in financial circles throughout the West.

Director and Vice President J. H. Tuttle also has been elected treasurer, succeeding Mr. O'Brien.

Office lunches are now equipped with vitamin capsules plus explanatory note.

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Oil Field Transportation and Especially Developed Equipment

S. H. Grinnell
Union Oil Co. of California

Ever since the wheel was invented, the owners of the wheel have attempted to speed up and increase the loading on that wheel. Some of these owners have done this without regard to the rights of their fellowmen. This has resulted in a legion of set state and local regulatory laws. Therefore, when the engineer attempted to design portable drilling and well-servicing equipment, he was faced with these laws and was handicapped considerably by them.

The first types of portable drilling equipment were various hoists set on trucks—the only thought back of their design being an ability to comply with the law and a hope that the equipment would be adequate for the work required.

As the wells became deeper, it was found impossible to design equipment which would comply with the laws and at the same time be of much value for the work for which it was intended. Therefore, the engineering department designed equipment to do the work, and it was the problem of the transportation men to move this equipment.

It is this problem of transportation that the author would like to discuss.

Two Classes of Equipment

For the purposes of this paper, the equipment will be divided into two classes:

1.—Portable equipment: defined as "that equipment which is moved daily on the highway, and which conforms to all state, county, and city laws."

2.—Mobile equipment: defined as "that equipment which is moved every two or three weeks and which does not necessarily conform to any laws and require permits if moved on the highway."

To give an idea of the problems of the designer in the State of California, it will be necessary to follow the geography of this State and the location of the oil fields. The state is made up of a high mountain range on the east—the Sierra Nevadas; a large central valley; a coast range, which runs north and south and swings in an easterly direction at Tehachapi and connects with the Sierra Nevadas; and a series of coastal plains bisected by various mountain ranges. This geography, roughly, isolates the oil fields into three separate areas, as follows: the Los Angeles Basin, the Santa Maria Valley and Coastal fields, and the San Joaquin Valley. In the movement of equipment and material from one area to another it is always necessary to cross a mountain range.

The railroads have tunneled through these ranges, and the tunnels are the factors which limit the engineer in the design of equipment. The dimensions as to size of units into which mobile equipment can be divided are, roughly: 15 ft. high, 11 ft. wide, and 50 ft. long.

Practically all the drilling equipment is of the mobile type and, when moved from one geographical location to another in the state, it is so designed that it can be broken down in size and so that it can be moved readily by trucks or shipped by rail. When in use in any area, the smaller shipping units are assembled in a master unit which generally is "overweight," "overheight," and "overwidth," thereby necessitating permits, and it must be moved on special transportation equipment.

Transportation of Drilling Derricks

Let us consider the transportation of drilling derricks. These derricks are either 136 ft. or 178 ft. high. Whenever possible, they are moved intact. Most derricks have a steel foundation which ties the legs together. The 178-ft. derrick, with steel foundation, weighs approximately 83 tons. Moving is accomplished either by putting track-laying wheels or rubber-tired dollies under the derrick and towing by tractor or truck. There is a steel I-beam protruding from two corners of the derrick; the derrick is jacked up and the track-laying wheels are slipped on—the protruding I-beams being used as axles. Directly opposite these two wheels is placed a steel I-beam equivalent to 12- in. on top of the steel foundation, making a total of 24 in. of 79-lb. steel to give additional support; a sway-backed dolly made of track-laying wheels is placed under the center of this I-beam. The advantage of three-point suspension is, that at all times, there are three points of contact with the ground; whereas, with four-point suspension, there is the possibility of high spots on the two diagonal corners which would cause rocking of the derrick, and also the possibility of an undue strain on members of the derrick. When the derrick is moved, some operators hang a plumb bob from the center of the derrick at the water table; and so long as this plumb bob hangs free within the derrick, the center of gravity is such that there is no danger of upsetting.

Some operators do not have steel foundations under their derricks. In cases of this kind sufficient steel and blocking are installed at the time of moving to support and tie the derrick legs together.

The cost of moving this equipment ranges from $500 for 2,500 ft.—taking 12 hours—to $1,000 for 3 miles, taking 32 hours. A crew of five men, a foreman, and two dual-drive trucks equipped with winches are needed to execute this move. One of the trucks is used as an anchor for the pulling truck. Some operators on the 136-ft. derrick use one tractor similar to an RD-8, which is equipped with a winch, in place of the two trucks.

The drawworks, the drilling engine, and the foundation are moved as a unit. This equipment is capable of drilling to approximately 15,000 ft. The total unit weighs approximately 53 tons. The sub-base is split horizontally — the bottom section being 32 in. to 34 in. high, which is the same height as the low-bed trailer on which it is moved. The upper section, which carries the drilling engine and drawworks, is slipped on a standard low-bed type of trailer that has sufficient capacity to handle the load. The 32-in. sub-base is picked up by a crane and placed on another truck; is moved to the new location; is set in place; and is ready to receive the engine, drawworks, and foundation. The equipment is unloaded by placing a winch truck on the opposite side of the derrick and pulling the equipment off.

The costs on this move range from $75 to $150, and the move takes from 5 to 7 hours. The men and equipment employed are: one truck, one crane, and one low-bed trailer; five men, including the truck drivers, crane operators, and foreman. It is estimated that, when moving this equipment as a unit, there is a saving in rigging up and dismantling of 60 to 70 man-hours, with no increase in transportation cost.

Boiler plants are so unitized that each boiler is mounted on a separate set of skids and carries all the piping and fittings necessary to operate that boiler. A steel sub-base placed on the ground is used for two purposes: 1, for locating the boilers and, 2, as a foundation. Each boiler, complete with fittings, weighs approximately 30 tons, and is loaded on a low-bed trailer with 2 cranes. At the new location the boilers are so placed on the sub-base that all that will be required for rigging up the plant will be to flange the piping of one boiler to the piping of the next boiler. The two water pumps, all gas and water controls, and water heater and electrical generators are placed on another set of skids which weighs approximately 15 tons. These auxiliaries are connected to the boilers with quick-change unions. The feed-

(Continued on Page 47)

Progress of Petroleum Industry in California

Reviewed at A. I. M. E. Annual Meet

(Continued from Last Issue)

"3. Substructure and working platform, 9 pieces; 4 bolts used for assembly and attachment to rig; all sections under 8 feet wide; rig floor 15 feet x 16 feet x 3 feet high.

"4. Tool rack on skids, 6 feet x 12 feet x 3 feet high.

"5. Pipe rack, wooden stringers on ground.

"The following table shows the average distribution of time for the first ten wells. These were all drilled to approximately 2000 feet in two different fields.

Averages of First Ten Wells

Operation	Hours Required	% of Total Time
Move, rig up, drill rat hole, spud in	26	10
On bottom drilling and reaming	43	16
Round trips to drill and ream	13	5
Round trips to core and service cores	12	5
Core	6	2
Formation testing and electric logging	12	5
Running casing, liners, and cementing	8	3
Standing cemented and recementing	69	26
Miscellaneous (oil machinery, repairs, circulate, etc.)	31	12
Bail, run rods and tubing	43	16
Total	263	100

"The item of standing cemented is high because of some troublesome recementing jobs included in the average.

"The drill pipe used has been both 4½-in. and 3½-in. while the holes have been either 10⅝-in. or 12¼-in.

"Butane consumption has been close to 1600 gallons per well. Electricity has been available for lighting at all locations because of the electric pumping equipment subsequently installed."

Ernest N. Merrill, consulting engineer and superintendent of Guijarral Service Co., abstracts his paper, "How The Small Operator Can Use Good Engineering Practice," as follows:

"In the group of small California oil operators with less than 100 wells each, the average number of wells per operator is six. With such few wells, the volume of engineering work done by the average company is so small that engineering services generally are obtained on a part-time basis or not at all.

"It is the purpose of this paper to review, in a general way, some of the work in which the help of an engineer can be a considerable benefit to the operator. Whether or not it would be profitable for a particular company to employ an engineer to do this work naturally depends on the circumstances involved.

"The acquisition and sale of producing or semi-proven properties often involve situations for which it is advisable to have technical assistance.

"Employment of engineers during deep drilling programs generally is taken for granted. Shallow wells usually do not present such technical problems in drilling, but often require equally important engineering work, notably in mapping the structure, analysing reservoir conditions, determining well locations and completion depths, and estimating profits.

"Engineers have a definite place in assisting the operator in arriving at more accurate estimates of costs and profits of prospective rehabilitation of old leases and in the economical accomplishment of any work that is undertaken.

"During routine production work, an engineer can be particularly helpful in planning for the future and maintaining adequate records."

In the abstract of his paper, "The Young Petroleum Engineer and His Future in Corporate Enterprise," Fremont R. Schmieder, Shell Coastal division manager, says:

"This paper gives the writer's views of the problems confronting the young petroleum engineer and his future in corporate enterprise and was prepared to enlighten young engineers, together with hundreds of others that have chosen to earn a livelihood and achieve their ultimate goal in the Petroleum Industry. The paper points out that management will reward the individual handsomely for demonstrated ability and accepting responsibility; less often for other talents. It mentions that rewards will be in proportion to efforts put forth.

"If you, the engineer, are not progressing as rapidly as you believe you should, you are advised to stop and take inventory of the situation. Self-analysis is pointed out as being a powerful X-ray and every one should use it often to better understand individual behavior and its relation to progress. The paper in conclusion states that the advancement of the science of engineering in Petrol-

Natural gasoline plants quickly follow the discovery of a new oil field.

Typical Jobs Now in Progress

Our current work includes--

Increasing Texas Distillate Recovery and Pressure Maintenance Plant, from capacity of 60,000,000 cu.ft./day to 120,000,000 cu.ft./day—Complete Absorption Plant to replace present Temperature Separation Method.*

Adding 800 Compressor H.P. to another Texas Distillate Recovery and Pressure Maintenance Project—discharge pressure 2,900 lbs.

Enlarging Absorption Gasoline and Pressure Maintenance Plant facilities at combination plant in Central Wyoming.*

Additional facilities in two Compressor Stations on major gas Transmission System in Missouri.

Two Gas Dehydration Plants, Gas Compressor Station, Gas Desulphurization Plant—all in northern Wyoming.*

Addition to large Compressor Station on major Gas System in Kansas.

Two Gas Dehydration Plants for major gas Transmission and Distribution System in Southern California.*

Two Gas Dehydration Plants in South Louisiana for one of the largest gas companies.*

Additional Compressor capacity on Main Line Gas Transmission System in Colorado.

Three Plants for removal of salt water from gas. Plants will process approximately 340,000,000 cu.ft./day. These are located in the Gulf Coast Region.*

Large Butane Standby Plant for blackout Airplane factory in California.*

Gas Dehydration Plant in Northern Texas for major Gas Company.*

Additional Compressor Station facilities on gas system in Montana.*

*Complete turn-key basis, including design and engineering, furnishing all materials and labor.

- ***Distillate Recovery Plants***
- ***Gas Dehydration Plants***
- ***Compressor Stations***
- ***Natural Gasoline Plants***
- ***Stabilization Plants***

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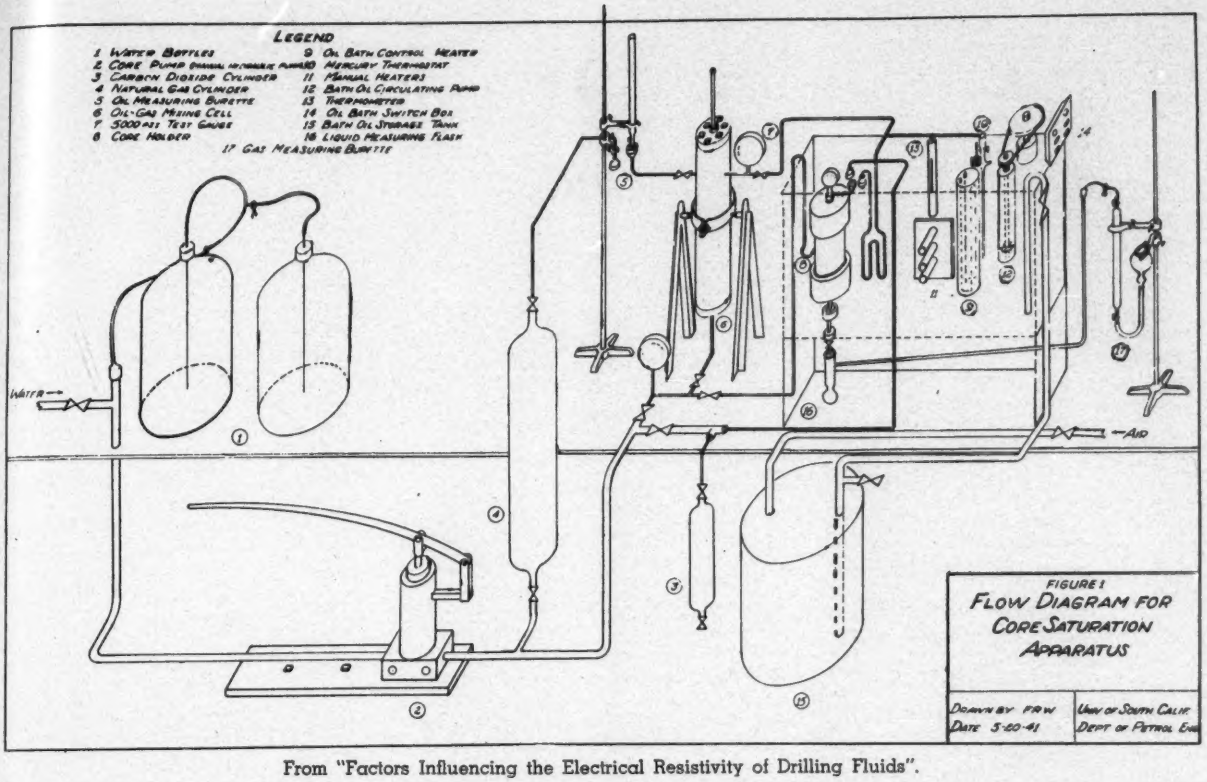


From "Factors Influencing the Electrical Resistivity of Drilling Fluids".

eum Production rests squarely on the shoulders of the engineer who has the courage to accept the problems of the industry and whose just reward is the achievement of the ambitions to which he aspires."

John E. Sherborne, petroleum engineer, and W. M. Newton, research engineer, in their paper, "Factors Influencing the Electrical Sensitivity of Drilling Fluids," say in part:

During recent years, the practice of "electrically logging" a geologic formation by means of a system of electrodes lowered in a well-bore, has provided data of inestimable value as to the nature of the sediments penetrated. Thus, it is generally possible, by means of electric logs, to distinguish readily between shales, sandstones, cherts, limestones, and other rock forms. The distinguishing characteristics recorded in this manner have made possible long range and closely detailed mapping and visualization of deeply buried structures to a degree not to be obtained with a reasonable expenditure of money by any other means at present in use.

Besides being of value in correlation work, electric logs have been found, in some instances, to be of value in estimating the nature of fluid contained within the pores of a rock. In special cases, even the relative permeabilities at different horizons have been determined. That electric logs should, in some measure, reflect such physical properties of rocks as porosity and permeability and, in addition, give rise to data pertaining to the fluid content of rock interstices, becomes evident when the conditions giving rise to the electrical phenomena measured are known. However, it is not the purpose of this paper to review the present status of electric logging; rather, the reader is referred to the papers cited in the bibliography for the principles and practice involved.

The purpose of this paper is, first, to present a report of the apparatus used and results obtained in a brief investigation into the effect which various factors such as temperature, chemical treatment, salinity contamination by cement, and the addition of weighting material may have upon the electrical resistance of drilling muds and their filtrates; and, second, to show the effect of the electrical resistance of the drilling fluid upon electric logs in some specific cases.

The writers summarize thus:

"The relation between the properties of electric logs and the fluid used in drilling a well has been briefly discussed. The fact that the resistivity of the drilling mud and its filtrate can appreciably effect such logs has been shown.

"Apparatus was designed and a procedure established to determine the effect of various factors on the resistivity of drilling mud. Five muds commonly employed in California were tested and the following observations were made:

"1. The effect of raising the temperature from 80 degrees F. to 180 degrees F. is to decrease the resistivity of the mud or filtrate approximately 50%. This appears to be roughly true for chemically treated muds as well as native muds.

"2. The resistivity of the mud in most cases closely approximates that of its filtrate. Therefore, the determination of the resistivity of a mud used in a well usually will provide a reliable picture of the resistivity of the filtrate that will be forced into the formation from the mud.

"3. The change in the resistivities of muds caused by the addition of chemical is not the same function of the amount of chemical added for each mud. Electrolytes used in mud treatment lower resistivity and, therefore, tend to decrease the sensitivity of electric logs. Non-electrolytes, such as quebracho, have little effect.

"4. The effect produced by increased sodium chloride content is to markedly reduce the resistivity of the mud and its filtrate. The fact was noted that when enough sodium chloride was added to a mud low in salt content so that its resulting salinity approached that of a more saline native mud, the resistivity of the mud so treated approached very closely that of the saltier mud. This in-

dicates that a knowledge of the chloride content of a native mud will enable, in many cases, the rough evaluation of its resistivity.

"5. Weighting materials, such as Baroid and Limestone, tend to increase the resistivity of drilling mud.

"6. Cement and sodium bicarbonate used in treating the mud for cement contamination result in reduced mud resistivity.

"7. Statistical data, and a few individual tests obtained under field conditions amply demonstrate the importance of the mud resistivity in its effect on electric logging and point to the need for further control in the field.

"The fact is recognized that the material herein presented represents only a reconnaissance of the problem investigated, and that further and more detailed study could profitably be made. It is hoped, therefore, that this brief study will stimulate further investigation.

"The writers wish to gratefully acknowledge their indebtedness to Howard C. Pyle and P. H. Jones for many helpful suggestions, to Robert Rose and C. F. Bowden who performed a number of the experiments, and to the Union Oil Co. of California for its release of the data presented."

Core Saturation Research at the University of Southern California was discussed by F. L. Ruhlman, lieutenant, U.S.N., and F. R. Wade, petroleum engineer. The paper was a progress report of core saturation experiments being conducted by the graduate students in petroleum engineering at the University of Southern California. The research is sponsored by the Junior members of the California chapter of the A.I.M.E. Under the auspices of this group the Union Oil Co. of California, the General Petroleum Corp., and The Texas Co. provided the necessary apparatus for the study. The immediate purpose of the work is to develop experimental relationships from the pressure depletion of cores saturated under reservoir conditions. From this information it is hoped that original formation fluid saturations may be more readily reconstructed from core analysis data.

N. van Wingen, Richfield Oil Corp. production engineer, abstracts his paper, "Field Application of Core Analysis and Depth-Pressure Methods to the Determination of Mean Effective Sand Permeability," thus:

Core Analysis Method: Effective sand permeabilities can be ascertained from core analysis if the laboratory data are compensated to allow for the presence of connate or residual water. Such adjustments can be made by applying empirically derived correction factors.

Depth-Pressure Methods: Effective sand permeabilities can be estimated also from analytical studies of field depth-pressure measurements. In one method the time rate of pressure build-up after a well is shut-in from steady state flow is required, and in the other the direct measurement of a steady state rate of flow and the corresponding equilibrium pressure.

Field Application: The results of the investigation discussed in this paper demonstrate that these three methods for determining mean effective sand permeabilities can be correlated.

"Problems of California Petroleum Geology," by Harold W. Hoots, chief geologist of Richfield Oil Corp., is abstracted as follows:

"The quantity of oil in the comparatively small total area of districts devoted to oil production in California leads to the conclusion that conditions important to the process of oil generation and accumulation were particularly favorable. The distribution of Tertiary seas, the types, quantity and relations of sediments, the abundance of marine life, the presence of enclosed basins of restricted circulation, and the history of deformation leading to the timely development of strategically located structural and stratigraphic traps all combined to concentrate an unusually large amount of oil in four small producing districts.

"It now appears that most of the oil in California, as well as in other states, has been discovered. Some of the problems important to the California petroleum geologist in his search for additional oil will be emphasized."

W. J. Travers Jr., Richfield Oil Corp. division superintendent, discussed "Completion Practices Related to Well Productivity."

"Several new procedures for completing oil wells," said the author, "have been developed in recent years. Each method when used where properly applicable promises to be a definite aid to operators in lowering development or operating costs or in developing the full potentialities of the oil well. Multiple zone completions are now frequently resorted to in contrast to the older practice of setting a solid water string over each zone to be produced. Gravel packing is often used in unconsolidated formations to prevent sand troubles formerly experienced where a conventional perforated liner was used. Light weight bentonitic clay muds and oil base drilling fluids are definite steps toward eliminating mudding damage which frequently results from use of heavy rotary mud.

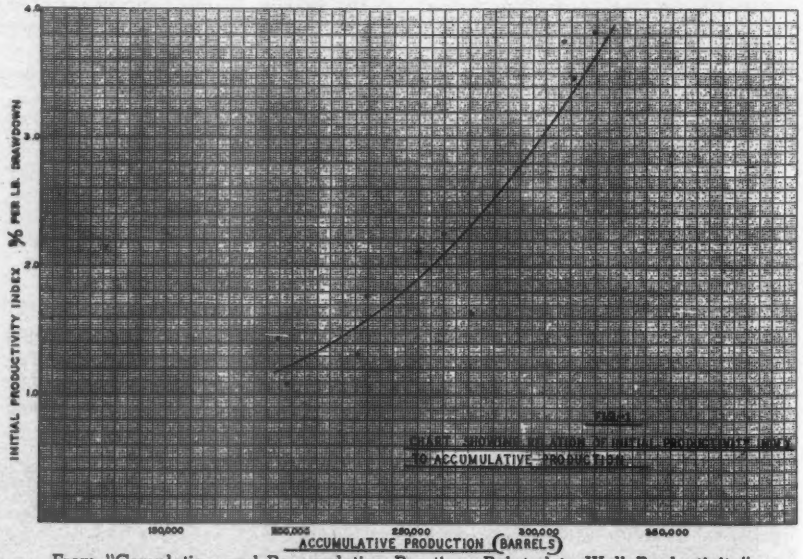
"Since in each case the new procedure developed is an alternate to older conventional methods, a problem of selection is presented. The purpose of this paper is to suggest methods of arriving at these choices and to present practical observations which may be of aid in their application."

A feature of the Los Angeles Meeting Was a Forum Session: "Is Unified Pressure Control Essential to Oil Recovery —The Paloma Plan?"

Discussing the Geology and Development of Paloma field, James T. Wood Jr., manager of The Texas Co. producing department, said:

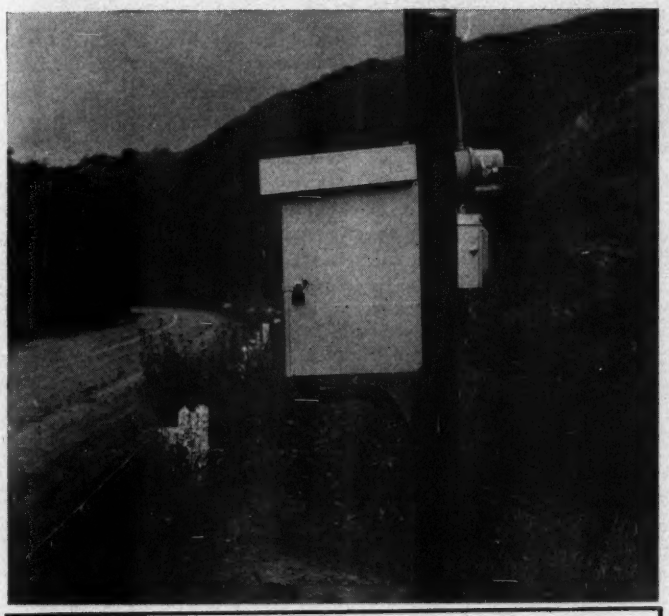
"The Paloma Field derives its name from the Paloma School, one-half mile north of what is now the center of the field.

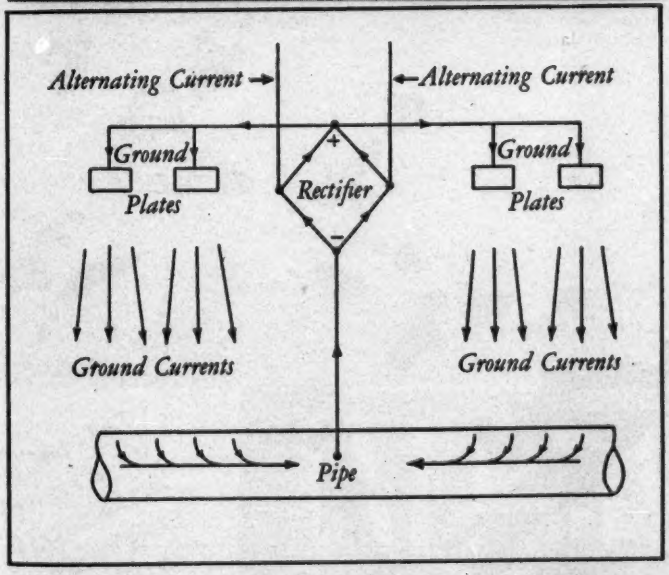
"The field is situated seventeen miles southwest of Bakersfield in the south central part of the San Joaquin Valley. The present developed area and its ex-



From "Completion and Recompletion Practices Related to Well Productivity".

STOP PIPELINE CORROSION WITH ★Electricity





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◀ *The diagram illustrates how cathodic protection is accomplished. The negative terminal of a source of direct current is connected to the pipe while the positive terminal is connected to a suitable ground plate.*

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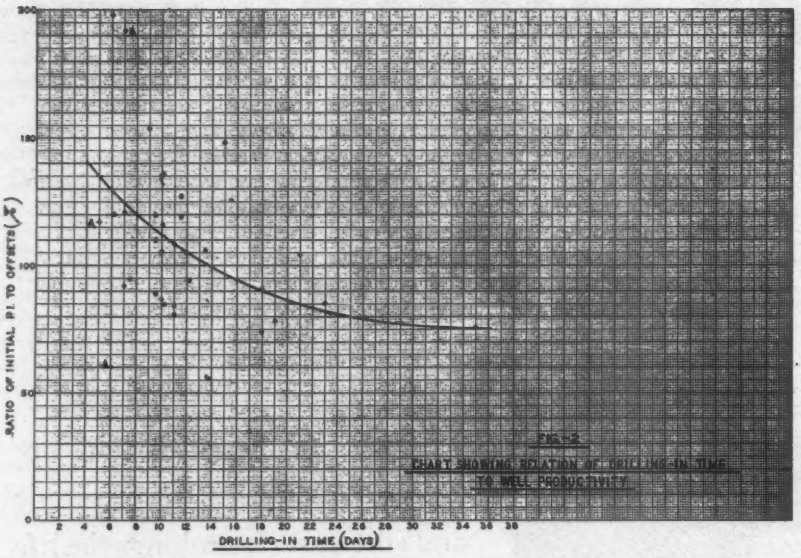


FIG. 2
CHART SHOWING RELATION OF DRILLING-IN TIME TO WELL PRODUCTIVITY

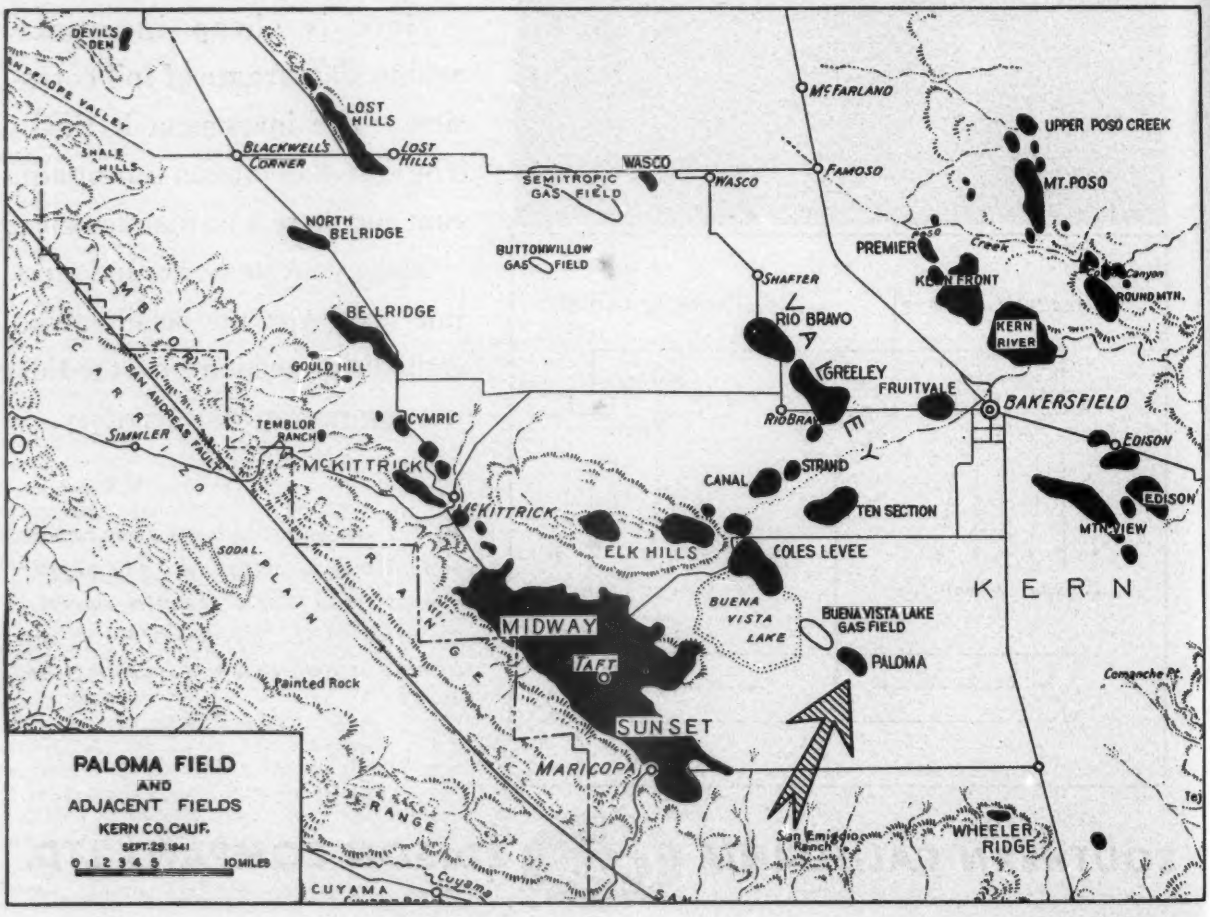
From "Completion and Recompletion Practices Related to Well Productivity".

pected extensions are in Townships 31 and 32 South, Range 26 East. (Relationship to other San Joaquin Valley fields will be shown on San Joaquin Valley field map). It is the most southerly of several fields which produce from the Stevens sand zone.

"The first well to produce condensate was a joint test drilled by the Western Gulf Oil Co. and The Texas Co. near the center of Section 3, T. 32 S., R. 26 E., well No. 54-3. This well was completed August 31, 1939, at a depth of 10,178 feet. The initial production was 2280 barrels a day of condensate and 14,750,000 cubic feet of gas (½ hour gauge) through a 3/8-in. bean.

"Prior to the drilling of this well, the Ohio Oil Co. discovered and developed a small gas field which embraces a part of three townships about their common corner, but lies chiefly in Sections 31 and 32, T. 31 S., R. 26 E. The first well was completed on July 1, 1934, at a plugged depth of 5239 ft. after having been drilled to 7957 ft. Production was found in a 59-foot zone located 110 feet below the Fourth Mya bed within the San Joaquin clays. Until recently this field was known as the Buena Vista Gas Field. It is now carried by the Division of Oil and Gas as the Paloma Gas Field. Production within the Paloma Gas Field is derived from six wells, producing from several different zones in the interval from 4177-5548 ft.

"The Paloma producing zone, frequently referred to as the Paloma sand, is encountered at depths ranging from 9950 ft. to 10,300 ft. It is, in general, a



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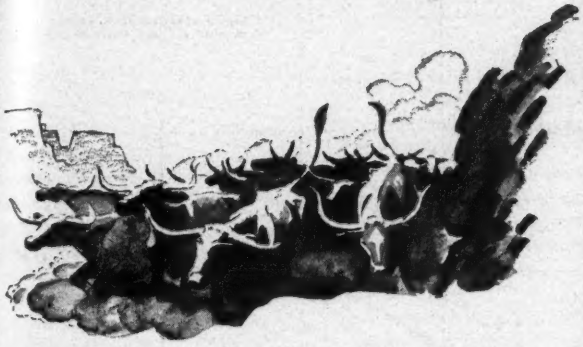

THE CHISHOLM TRAIL has become a memory of the old West. One of its terrifying menaces, the stampede, remains however in another form to impede clear thinking and sound action of the present day.

Stampedes have always been the result of panic. In the '60's a loose blanket flapping in the wind at night might send 10,000 Texas Longhorns running madly and trampling all before them until they dropped from exhaustion. In 1941 careless words and cloudy thoughts may likewise stampede otherwise normal individuals and organizations.

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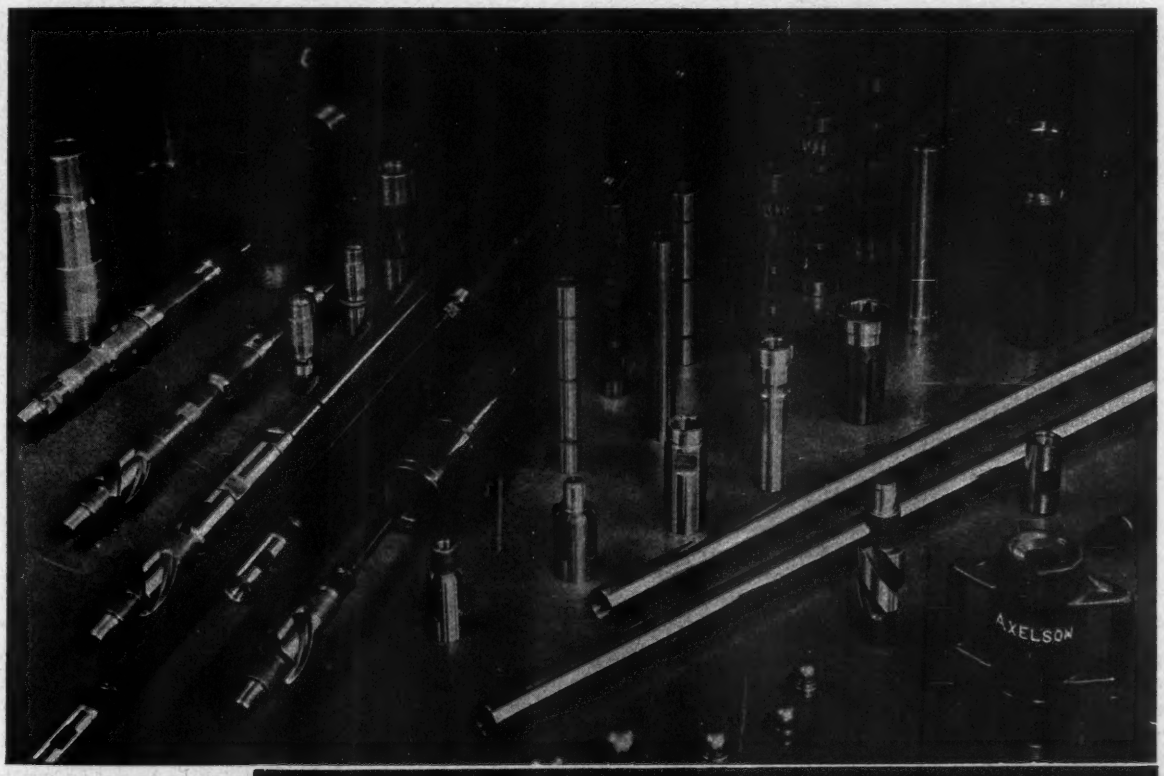

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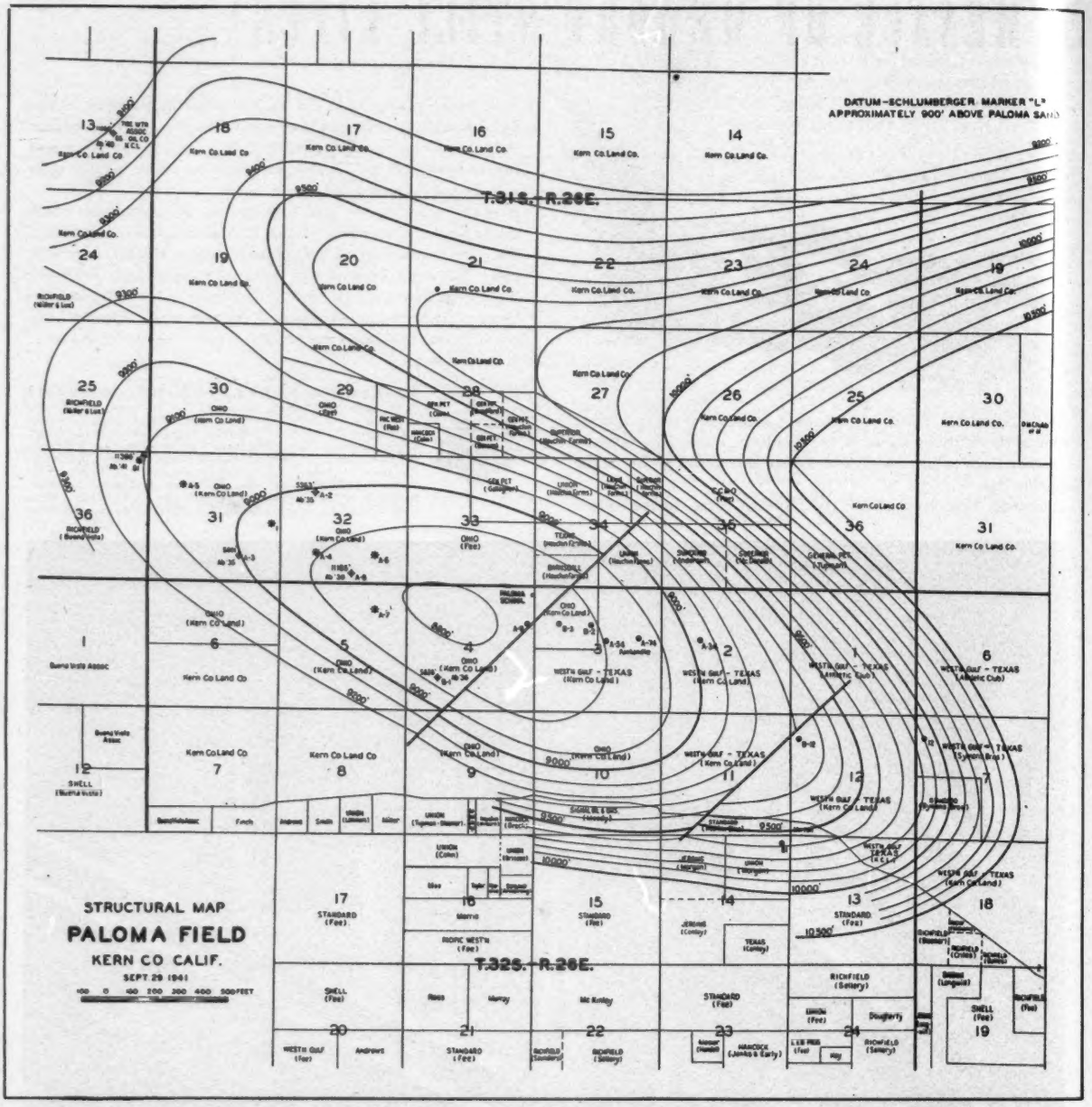


massive, firm to hard, not too well sorted, fine to medium fine sand. It is interbedded with thin hard calcareous sand shells of similar texture and cherty or dark brown siliceous shales. One conspicuous shale bed varying from 10 to 50 feet in thickness generally occurs within the upper 100 to 150 feet of sand.

"Fresh cores from this zone have been characterized by light tan distillate stains and have a strong gasoline odor. When dry the same cores have an unpleasant smell described by one observer as a 'sour sock' odor. Material resembling Grahamite and giving a dark cut with carbon tetrachloride is frequently found in the sand.

"The total effective sand thickness of the productive zone at Paloma is estimated to be from 200 to 250 feet in the wells now completed. Core analysis indicates an average porosity of about 20% and an average permeability somewhat less than 100 millidarcys. Streaks of sand having permeabilities of 100 to 500 millidarcys are found throughout the section, but these are doubtless of limited extent, as they do not correlate from well to well.

"Development is still too limited to define the thickness, distribution and reservoir characteristics of the producing zone throughout the Paloma Field. With but one or two exceptions, the wells drilled to date have been located along lines of nearly equal sand thickness. Western Gulf B-12-12 is located approximately three-fourths of a mile south of an east-west line passing through the present producing wells. If the upper 90 to 125 feet of sand in this well is conceded to be a new member, the Stevens sand as known elsewhere in the field has decreased in thickness. Union Oil Co. Morgan No. 81-14, Section 14, T. 32 S., R. 26 E., was abandoned at a depth of 11,456 feet. This well penetrated approximately 285 feet of sand between 10,640 and bottom. Approximately 213 feet of sand between 10,640 and 10,853 is considered the equivalent of the B-12-12 sand.

(To Be Continued)

Polyform and Gas Reversion Process and the Natural Gasoline Industry

C. N. G. A.
Fall, 1941

By
E. R. Smoley and V. O. Bowles
The Lummus Company

The great recent demand by the United States Defense Council and the Army and Navy for large quantities of high-octane gasoline makes this paper especially timely. In this present war emergency, oil men must carefully consider every method of producing the highest grade of gasoline at the lowest possible cost. Perfection of product is, of course, paramount. But economy in production both as to money and material is vitally important, too. The utilization of propanes and butanes from the natural gasoline industry for the economic production of high octane gasoline adheres to this program, as does also the production of butylenes for the manufacture of valuable aviation alkylate. Large government orders and demands for high octane gasoline have already caused many oil refining companies to investigate and install the new Polyform and Gas Reversion Processes because these processes make both cheaper and better gasoline of higher octane number.

Throughout the country Polyform and Gas Reversion Plants now process close to 100,000 B/D of naphthas, propanes and butanes, of which approximately one-third are propanes and butanes; a good share of these come from the natural gasoline industry. A year ago there were 11 Polyform installations. Today there are 14 such plants in operation and 4 more under construction. The operation of the last two units recently completed has greatly exceeded expectations in yield, octane and general results.

Because of defense requirements for vast quantities of high octane aviation and motor fuels, and because of the commercial demands for ever higher and higher octane number gasoline, every refiner is vitally interested in elevating the octane of his production by new refining methods. To illustrate these rising trends of motor gasoline octane number, the data submitted by the Bureau of Mines Cooperative Fuel Research Motor Gasoline Survey over the past five years are presented here. Figure 1 shows the trend of the average motor fuel octane numbers in the United States from 1936 to date. The premium grade his risen from 76.8 in 1936 to 80.4 in the winter of 1940-41, indicating a rising trend of one octane number per year. The regular grade has risen from 69.5 ASTM octane to 74.5 during this same period, while the third grade rose from 57.2 to 65.5. Current defense requirements are making it more and more difficult for refiners to maintain the high-octane of their commercial production. This has already been recognized by many refiners who are installing refining processes such as the Polyform Process, which produce large volume of higher octane number gasoline for blending with the refinery production.

Means for many phases of octane number improvement may be provided by the Naphtha Polyform and Gas Reversion Processes. Straight run heavy naphthas may be polyformed for the production of high yields of 76 to 80 ASTM octane number gasoline. Straight run gas oil, recycle gas oil, or catalytically cracked gas oils may be polyformed to 74-76 ASTM octane number with improved yields over conventional processing, and reduced crude may be polyformed at higher conversions per pass for the production of 70-72 ASTM octane number gasoline. Heavy cracked gasoline may be polyformed satisfactorily to 76 ASTM octane to further improve refinery octane numbers. The use of outside propanes and butanes either from refinery gas or from natural gas in Naphtha Polyform and Gas Reversion Units has resulted in high yields of high octane number gasoline from this source of raw material. The gasoline produced from Polyform Units has excellent blending value and good lead susceptibility. The spread between the ASTM and the Research octane number varies from 9 to 14 points and the appreciation of road octane number is excellent. Standard road tests have indicated that naphtha polyform gasoline of the same octane number is equivalent to gasolines made from catalytic processes.

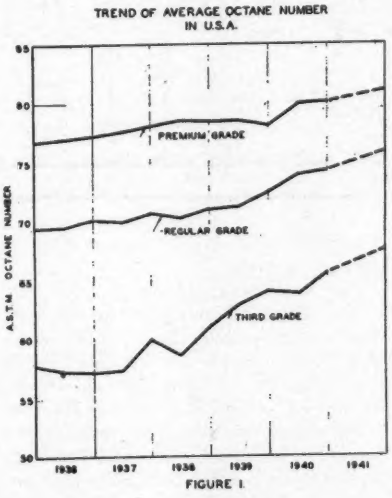
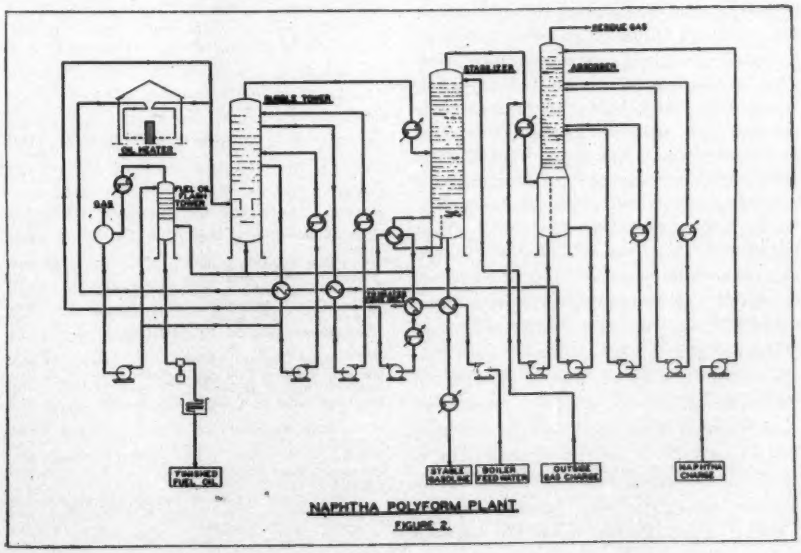


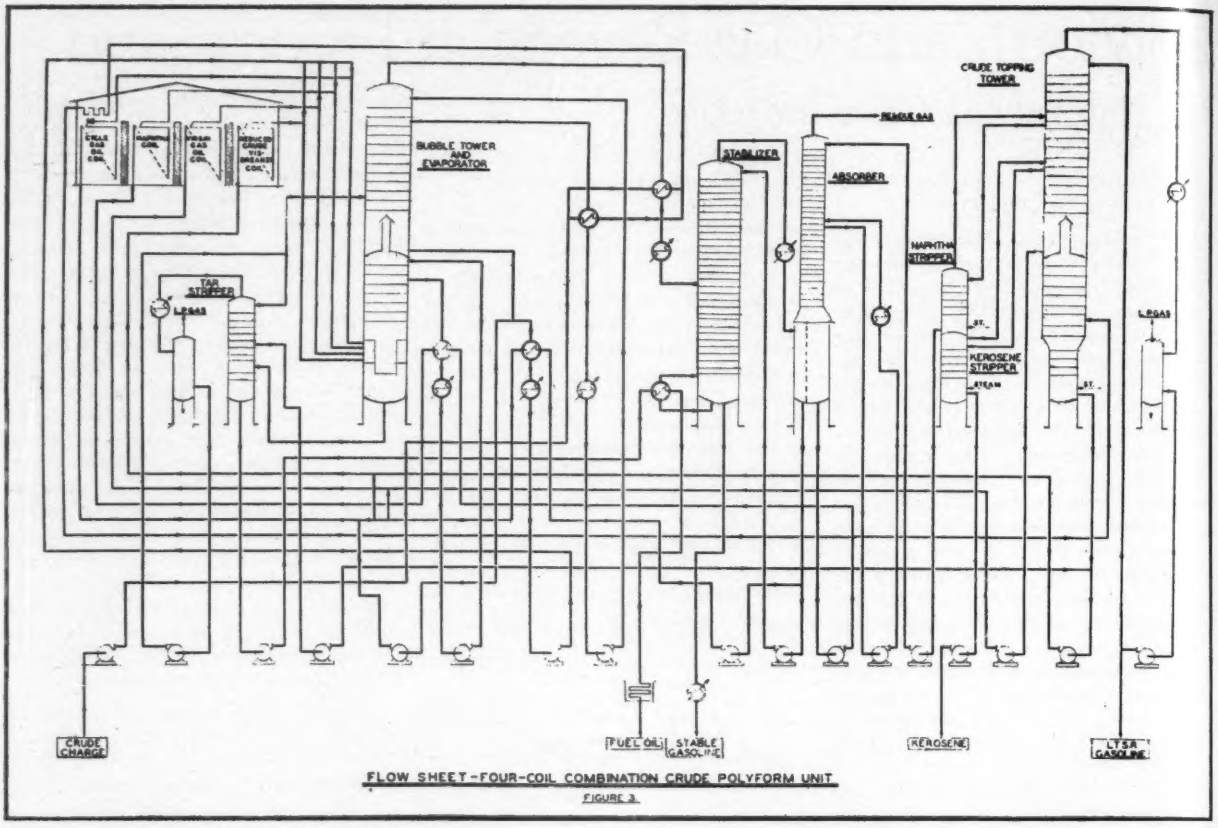
FIGURE 1.

Aviation fuels which lead up to 91 ASTM octane number with less than 4 cc. of lead and meeting all Army specifications may be made from the Polyform process. This stock may also be used as a base for blending with isopentane and aviation alkylate or isooctane and 3 cc. of lead to produce 100 octane aviation fuel meeting all of the Army specifications. The polyform distillates are rich in aromatics containing from 3 to 5% toluene which may be economically recovered as nitration grade toluol by well known process methods.

A very interesting application of the Polyform process is the by-product production of a butylene cut which may be



NAPHTHA POLYFORM PLANT.
FIGURE 2.



FLOW SHEET—FOUR-COIL COMBINATION CRUDE POLYFORM UNIT

FIGURE 2

used for the manufacture of aviation alkylate. The normal butanes from the Alkylation Plant are returned to the Polyform Unit to complete the cycle. The use of field butane in a Polyform Unit for the production of a BB cut for the manufacture of aviation alkylate will add to defense resources.

The Naphtha Polyform and Gas Reversion Processes, as most of you already know, employ the principle of cracking an oil in admixture with various amounts of normally gaseous hydrocarbons (propanes and butanes). The oil in this mixture can be subjected to higher temperature and higher degree of conversion per pass than possible in the ordinary thermal cracking process without the danger of coke formation in the cracking tubes, and without uneconomically large production of residue gases. Cracking velocities of individual propanes and butanes are increased when admixed with naphtha because of cooperation and partial consumption by alkylation and other synthesis reactions. Thus admixed gases have a pronounced physical effect on naphtha reforming which takes place concurrently with gas polymerization. Conversion conditions in naphtha reforming can be made more severe with attendant greater octane number improvement when the paphtha is admixed with gas conversion stock in sufficient amount.

The Naphtha Polyform and Gas Reversion Processes as applied to the conversion of low-octane heavy naphtha into high-octane gasoline are illustrated in the flow-sheet, Fig. 2. The naphtha charge is pumped to the top of the absorber tower where it absorbs the propane and butane recycle from the unit. This rich naphtha serves as the furnace charge and after picking up preheat through exchargers passes through the furnace where outlet conditions of approximately 1050°F. and 1200 pounds pressure are maintained. The furnace outlet is quenched with circulating oil from the bottom of the evaporator tower and discharges into the evaporator and bubble tower which operates at about 400 pounds pressure and 625°F. flash temperature. The end point gasoline is distilled overhead and stabilized. The stabilizer overhead consists of the propane and butane recycle, and the residue gas, which flow through the condenser into

TABLE 1
BUTANE AND PROPANE CONVERSION
IN A NAPHTHA POLYFORM OR GAS REVERSION UNIT

	Case I-A	Case I-B	Case I-C	Case II-A	Case II-B	Case II-C
Charge	Butane	Butane	Butane	Propane	Propane	Propane
Source	Natural Gas	Fuel Gas	Plant Flare	Natural Gas	Fuel Gas	Plant Flare
Quantity, Bbls./Optg. Day	1,000	1,000	1,000	1,000	1,000	1,000
Yields:						
Gasoline, Bbls./Optg. Day	460	460	460	350	350	350
Fuel Oil, Bbls./Optg. Day	35	35	35	25	25	25
Fuel Gas, Bbls./Optg. Day (F.O.E.)	280	280	280	305	305	305
Charge Value*, $/Day	840	440	.....	420	395	.....
Operating Costs**, $/Day	135	135	40	275	275	75
Management, Interest, Taxes, $/Day	75	75	75	140	140	140
Total Charges, $/Day	1,050	650	115	835	810	215
Gasoline Value @ 7.0¢/gal., $/Day	1,350	1,350	1,350	1,060	1,060	1,060
Fuel Oil Value @ $0.70/Bbl., $/Day	24	24	24	17	17	17
Fuel Gas Value @ 10¢/MM Btu, $/Day	175	175	.....	191	191	.....
Total Receipts	1,549	1,549	1,374	1,268	1,268	1,077
Net Return, $/Day	499	899	1,259	433	458	862
Net Return, $/Year	165,000	297,000	415,000	143,000	151,000	285,000
Increment Plant Cost, $	285,000	285,000	285,000	485,000	485,000	485,000
PAYOUT TIME, YEARS	1.7	1.0	0.7	3.4	3.2	1.7

*—Natural Butane @ 2.0¢/gal., Natural Propane @ 1.0¢/gal., Fuel Gas @ 10¢/MM Btu.
**—Utilities: Fuel @ 10¢/MM Btu, Water @ 0.5¢/1000 gal., Power @ 0.5¢/KWH, no plant steam required.

TABLE 2
COMMERCIAL POLYFORM OPERATION OF TEXAS NAPHTHAS WITH OUTSIDE PROPANES AND BUTANES

Research Octane No.	87.5	81.0
Operating Data:		
Coil Outlet Temp. °F.	1062	1040
Coil Outlet Pressure, Lbs./Sq. In.	1200	1200
Evaporator Bottom Temp. °F.	625	625
Evaporator Press., Lbs./Sq. In.	390	390
Absorber Pressure, Lbs./Sq. In.	340	340
Yields, Volume %		
Charge Naphtha	100.0	100.0
Butanes	20.7	20.3
Propanes	16.6	15.4
Stablized Gasoline	98.0	110.0
Fuel Oil	4.8	2.4
Calculated Vol. % Stab. Gasoline on Naphtha Alone	83.5	95.5

Laboratory Inspections:

	Charge Naphtha	Stab. Gasoline	Tar	Stab. Gasoline	Tar
A.P.I. Gravity	51.2	57.2	9.5	59.2	12.0
R.V.P., Lbs./Sq. In.		9.7		10.0	
Visc. SUS @ 122°F.			19		15
B.S. & W., %			0.4		0.4
A.S.T.M. Distn., °F.:					
I.B.P.	205	95		94	
10%	260	130		134	
50%	310	232		243	
90%	360	339		327	
End Point	400	389		385	
Research Octane No.	44.0	87.5		81.0	

TABLE 3
PILOT PLANT DATA PLOYFORMING CALIFORNIA NAPHTHA

Run No.	1	2	3	4
Operating Data:				
Coil Outlet Temp. °F.	1070	1080	1090	1100
Coil Outlet Press., Lbs./Sq. In.	1500	1500	1500	1500
Tower Press., Lbs./Sq. In.	300	300	300	300
Yields, Vol. %				
Stablized Dist.	92.4	90.3	83.9	79.7
Tar	1.3	1.6	3.8	4.8
Gas F.O.E.	6.2	7.3	12.2	15.2

Laboratory Inspections:

	Charge Naphtha	Stab. Gasoline	Tar	Stab. Gasoline	Tar	Stab. Gasoline	Tar	Stab. Gasoline	Tar
A.P.I. Gravity	52.9	55.1	16.3	54.2	10.0	53.5	8.2	53.6	8.3
R.V.P. Lbs./Sq. In.		8.8		8.5		9.5		9.1	
A.S.T.M. Distn. °F.:									
I.B.P.	160	93	394	95	426	94	421	92	428
10%	211	153	485	155	500	144	491	139	480
50%	267	247	526	245	599	238	591	234	571
90%	344	348		360		349		359	
End Point	397	404		420		413		408	
A.S.T.M. Octane No.	58.3	73.8		75.5		78.2		79.3	
Research Octane No.		83.7		86.3		89.4			

the absorber tower where the residue gas is separated from the balance of the recycle. The processing of outside propanes and butanes may be carried out in this unit by adding these materials to the stabilizer overhead or as liquid feed to the furnace charge pump.

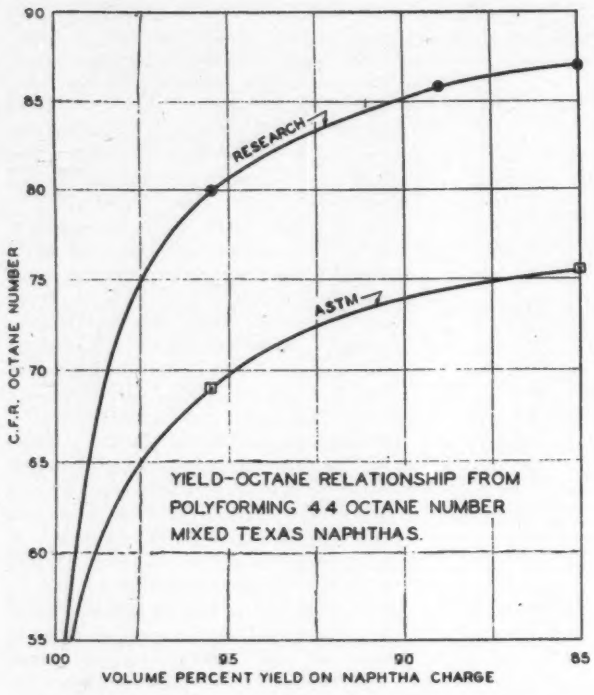
The application of the Polyform and Gas Reversion Process to the cracking of a full crude is illustrated in the four-coil Combination Crude Polyform Unit Flow-Sheet, Figure 3. This flow-sheet illustrates a 22,000 B/D Crude Topping and Polyform Unit. This one unit replaces the conventional type of crude topping and cracking unit, a thermal polymerization unit and a gas compression and absorption plant.

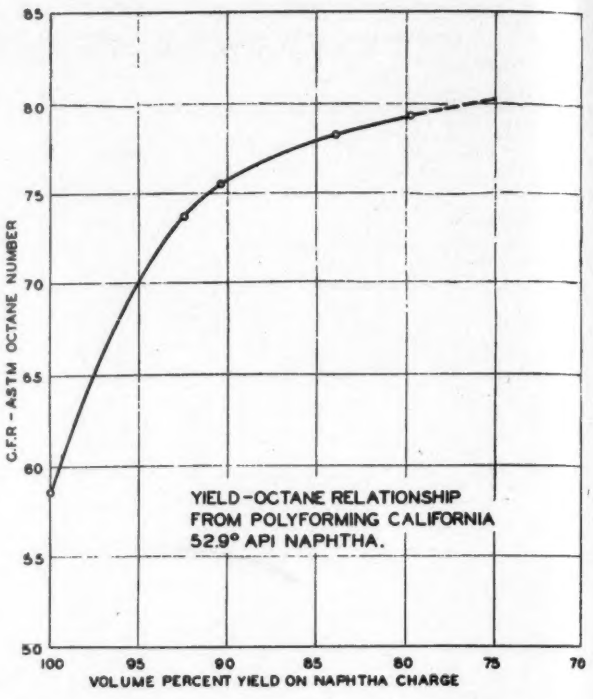
The flow is simple. Crude is charged through heat exchangers and a heater convection bank into an atmospheric crude topping tower from the top of which straight-run gasoline is removed. Heavy naphtha and furnace oil or kerosene side-streams are withdrawn through stripping towers, and below the furnace oil drawoff a virgin gas oil cut is removed. This virgin gas oil cut is charged hot with propanes and butanes to the virgin gas oil polyform coil where 34-35 percent gasoline production per pass is obtained. Heavy reduced crude is charged hot from the bottom of the atmospheric tower through the polyform vis-breaker coil together with the heavy tar stripper side-stream and propanes and butanes at a conversion per pass of approximately 14 to 16 percent. The light recycle stock from the base of the fractionating tower is cracked in the recycle polyform coil with the propanes and butanes to approximately 25 to 32 percent gasoline per pass. The C_3 and C_4 diluent for these three coils is all furnished as condensate from the stabilizer overhead and is composed of approximately 25 percent butanes and 75 percent propanes. Heavy naphtha is passed over the absorber to separate the propane and butane recycle from the residue gas, and the rich naphtha from the base of the absorber is polyformed in the naphtha polyform coil. All four coils discharge into a common separator tower. The 10° to 12° A.P.I. gravity bottoms from this tower is reduced in the atmospheric tar stripper to the desired fuel oil gravity, the overhead from the tar stripper returns to the bubble tower, and the side stream goes to the reduced crude vis-breaker.

Conversion of propanes and butanes

Resulting increase in tetraethyl lead requirements, therefore, sets a high value on any new high octane production such as may be obtained from propanes and butanes. Table 1 illustrates the profitability of converting propanes and butanes in an average size Polyform Unit. The values of the propane and butane charges have been varied according to the sources of these materials. Field butane was considered to be available at 2 cents per gallon. Field propane was considered available at a cost of one cent per gallon. With gasoline bringing 6 and 6½ cents per gallon at the refinery, an average value of 7 cents per gallon for this high-octane gasoline production appears reasonable, the difference representing tetraethyl lead savings. Thus, with present-day plant costs, a payout on the increment investment of 1.7 years for field butane charge, and 3.4 years for field propane charge is indicated. If these propanes and butanes are obtained at fuel gas value, payouts of 1.0 and 3.2 years respectively will be realized; while, if the propanes and butanes are obtained from the plant flare (having no value) then payouts of 0.7 and 1.7 years respectively may be obtained. The processing of propanes and butanes in a Polyform or Gas Reversion Plant adds only to the operating expense some utilities and maintenance.

The use of natural gasoline in the direct manufacture of 100 octane aviation gasoline simultaneously with high-octane motor gasolines is an application for the Polyform and Gas Reversion Processes which will interest all natural gasoline producers. The hypothetical operation shown in the following example indicates a high potential production of 100 octane aviation gasoline from field casinghead. For example, consider a producer who has available 5000 B/D of 26 pound casinghead containing approximately 3000 B/D of iso-pentane-free natural gasoline, 350 B/D of iso-pentane, 1100 B/D of normal butane and 550 B/D of iso-butane. This stock would be deisopentanized and debutanized and the gasoline separated by distillation into aviation base stock and a heavy naphtha. The heavy naphtha (1500 B/D) would be polyformed with 1100 B/D of normal butane for the production of 1300 B/D of 76 octane motor gasoline and at the same time a by-product butane-butylene stream would be withdrawn and charged to an Alkylation Plant along with the 550 B/D of iso-butane with a production of approximately 1000 B/D of 93-95 octane aviation alkylate. The normal butane from the alkylation operation would all be recycled to the Polyform Plant. The alkylate would be blended with the 350 B/D of iso-pentane and 500 B/D of the avia-


C.F.R. OCTANE NUMBER
RESEARCH
ASTM
YIELD-OCTANE RELATIONSHIP FROM POLYFORMING 44 OCTANE NUMBER MIXED TEXAS NAPHTHAS.
VOLUME PERCENT YIELD ON NAPHTHA CHARGE


C.F.R - ASTM OCTANE NUMBER
YIELD-OCTANE RELATIONSHIP FROM POLYFORMING CALIFORNIA 52.9° API NAPHTHA.
VOLUME PERCENT YIELD ON NAPHTHA CHARGE

tion base stock produced from the original natural gasoline, resulting in a net production of 1850 B/D of leaded 100 octane gasoline. Thus a charge of 5000 B/D of 26 pound casinghead of the characteristics noted could produce 1850 B/D of 100 octane aviation gasoline plus 2300 B/D of 73 ASTM octane motor gasoline. This example indicates a high volumetric yield of 100 octane aviation and high-octane motor gasoline from the original natural gasoline charge.

Operating data from commercial Polyform and Gas Reversion Units have been published in the oil journals September, 1940, and the American Petroleum Institute Proceedings November, 1940. Yields, octanes, lead susceptibility, inspections of charge and products, operating conditions, and blending results are given for various types of charge stocks and operations. A large Polyform Unit charging straight run naphtha of 250-400°F. boiling range and about 45 octane number from a mixture of Texas and Coastal crudes along with outside propanes and butanes has recently been completed and placed on initial operation. During two four day test runs with frequent gaugings, accurate yields of 83.5% of 10 R.V.P. 400 end point gasoline with a Research octane number of 87.5 and 95.5% of 10 R.V.P. 400 end point gasoline of 81.0 Research octane number were established. Table 2 presents some of the operating data. This yield-octane relationship as shown in Figure 4 for both the Research and ASTM octane numbers is well substantiated by more than 750,000 barrels of gasoline production in this plant at varying octanes.

A series of runs were made in the pilot plant, processing 52.9 API gravity California naphtha with a boiling range of 160-400° F. end point, having 58.3 ASTM octane number. The runs were made at a coil outlet pressure of 1500 lbs. and temperatures ranging from 1060°F. 1100°F. The operating conditions, yields, octanes, inspections of charge and products are given for the four runs in Table 3. Figure 5 shows the yield-octane relationship, indicating an 80% yield of 79 ASTM octane number gasoline and a 90% yield of 76 ASTM octane number gasoline. As would be expected from this California naphtha charge stock, a considerably higher yield-octane relationship was obtained than from Mid-Continent or Texas naphthas. These results indicate at least a 5% higher yield at this octane range than from Texas stocks.

Because of the naturally high octane number characteristic of most California straight-run gasolines, and because of the generally higher octane of cracked gasoline produced from the heavier oils, reforming California straight-run naphthas has not been practiced widely until very recently. However, the effect of defense requirements on the quality of commercial gasolines production, as well as the ever rising octane level of all grades of gasoline will make it exceedingly difficult for most refiners to maintain the present high octane level of their commercial production, even with all existing cracking facilties being employed to the fullest extent. For this reason the processing of low-octane gasoline components in Polyform and Gas Reversion Units is rapidly becoming a necessity. The production of high octane gasoline from propanes and butanes not now being diverted to gasoline production is especially profitable where it can be carried out concurrently with naphtha polyforming, and is a step forward towards the more efficient utilization of the nation's natural resources. This is particularly desirable during the defense emergency. The by-product manufacture of butylene for the production of valuable aviation alkylate is, furthermore, becoming imperative. Refiners are recognizing these factors everywhere and the Polyform and Gas Reversion Processes should find even greater application in the refining industry in the future.

C. N. G. A.

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Analysis of Hydrocarbon Gas Mixtures

By Mass Spectrometry

C. N. G. A.
Fall, 1941

By Herbert Hoover Jr. and
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The purpose of presenting this paper to the C.N.G.A. is to acquaint the members with the progress that has been made in applying the mass spectrometer to the analysis of certain gas mixtures which are of particular interest to the gasoline industry at this time. This may be especially true in view of some of the problems that have arisen in conjunction with the national defense program.

In a previous paper, one of the methods used in analyzing a gas mixture with the mass spectrometer was described. The present paper deals mainly with the results of some of the test analyses which have been made since that time.

Before giving these results, a short review of the method of operation of the mass spectrometer may be of interest. The mass spectrometer is an instrument for sorting molecules according to their weight or mass and then measuring the relative number of molecules of each mass present in the mixture being analyzed.

Fig. 1 is a diagrammatic sketch of the Dempster or 180° type of mass spectrometer. The gas mixture to be analyzed enters through the gas inlet to the chamber "a."

Before the molecules are sorted, they are given an electric charge so that they can be forced to move by the combined action of electric and magnetic fields. The production of an electric charge on a molecule, or ionization, is accomplished by bombarding the molecules with a stream of electrons in an ionization chamber. This chamber and associated electron source or filament is shown schematically in Fig. 1 at letter "a." The ions are then pulled out of chamber "a" by means of the electric field existing between slits "e" and "f." They enter the analyzer tube with a high velocity and are sorted out according to their mass by the action of a magnetic field. The magnetic field causes heavy ions to follow a circular path which is of greater radius than the path followed by lighter ions. The radius of the path foran ion of given mass can be made smaller or larger by varying the electric field produced between slits "e" and "f." Therefore by gradually varying the electric field, ions of each mass can be caused to fall successively on the collector "c" where their quantity is measured by amplifying and recording equipment. The resulting record shows the relative numbers of ions of each mass which appear at collector "c." From the data on this record the composition of the gas mixture which entered the gas inlet may be computed.

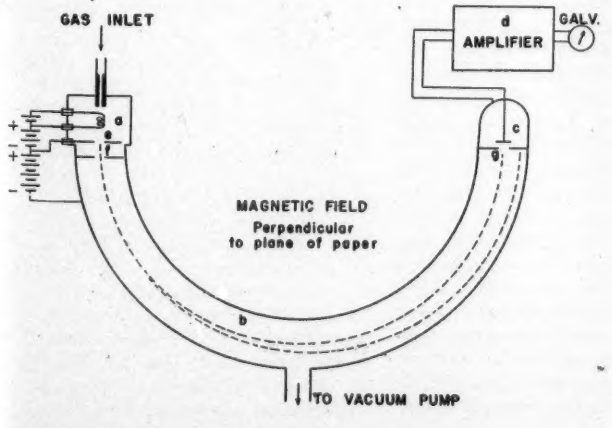
The actual apparatus that is now in use in our laboratories and the methods of interpretation that must be employed if accurate results are desired, are considerably more complicated than is indicated by the brief description that is included above. Three years of intensive research and development, which has involved thousands of test runs, have been required to bring the technique to its present stage of reliability. It may be some time before instruments can be made available for routine purposes in refineries and chemical plants generally. In the meantime, and particularly in view of the national emergency, certain types of gas mixtures that are difficult or time-consuming to analyze by other methods are being run in our own laboratory, under the direction of the research staff.

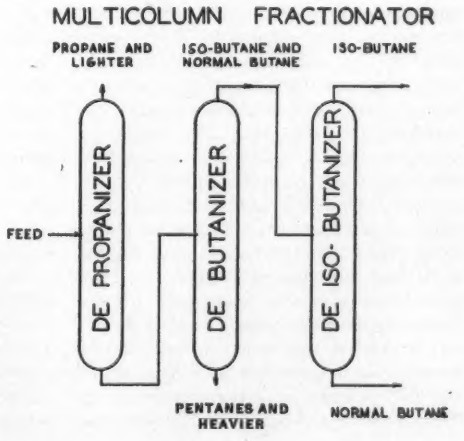
The results of some analyses will now be given in order to demonstrate the accuracy at present obtainable as well as the type of analyses which may be of immediate value to the petroleum industry.

The first examples to be chosen are samples which might be obtained from the multiple column fractionation apparatus shown in Fig. 2. The examples will be considered in the following order:

1. depropanizer overhead
2. debutanizer overhead
3. de-isobutanizer overhead and kettle products.

In the analysis of a depropanizer overhead, the main item of interest is the amount of iso-butane being carried off. Four analyses are shown in Fig. 3. The unknown samples were made by carefully mixing pure components, the amount of each component introduced being determined by a manometer. The mixtures as measured in this manner are shown in column I, labeled "Manometer." The relative amount of each constituent as determined by analysis with the mass spectrometer is shown in column II, labeled "Mass Spectrometer." The percentage difference between these two values is shown in column III, labeled "Difference." The differences, undoubtedly are not solely due to errors in the analysis, but may be due in part to slight errors in preparing the mixtures even though every possible precaution was taken to insure their accuracy. In these examples and in others to follow, the composition was unknown to the individual making the analysis in order to obtain an unprejudiced determination of the accuracy of the method. Fig. 3, shows that out of the four samples run, the maximum error in the determination of any of the components was 1.3%





DE-PROPANIZER OVERHEAD

	Manometer Percent	Mass Spectrometer Percent	Difference
Methane	19.1	19.5	0.4
Ethane	37.7	38.0	0.3
Propane	39.6	39.0	0.6
Iso-Butane	2.1	2.0	0.1
N-Butane	1.5	1.5	0
Methane	19.4	20.1	0.7
Ethane	38.0	38.1	0.1
Propane	38.4	37.4	1.0
Iso-Butane	2.4	2.6	0.2
N-Butane	1.8	1.8	0
Methane	39.2	40.1	0.9
Ethane	52.3	51.7	0.6
Propane	3.7	3.2	0.5
Iso-Butane	3.1	3.2	0.1
N-Butane	1.7	1.6	0.1
Methane	42.7	43.5	0.8
Ethane	0	0.4	0.4
Propane	52.6	51.3	1.3
Iso-Butane	3.0	3.0	0
N-Butane	1.7	1.8	0.1

Fig. 3

DE-BUTANIZER OVERHEAD

	Manometer Percent	Mass Spectrometer Percent	Difference
Iso-Butane	49.9	50.6	0.7
N-Butane	50.1	49.4	0.7
Propane	4.2	4.2	0.0
Iso-Butane	47.8	48.6	0.8
N-Butane	48.0	47.2	0.8

Fig. 4

and that the maximum error in determining the amount of iso-butane which is usually the main item of interest, was only 0.2%.

The small amount of N-butane was purposely added in order to demonstrate the ability of the new method of analysis to distinguish between butane and iso-butane when both are present in small quantities. These examples also demonstrate the ability to analyze for a small amount of a heavy constituent in the presence of large amounts of lighter constituents.

To illustrate the second example outlined above, namely, the debutanizer overhead, two mixtures were chosen as shown in Fig. 4. The first mixture is composed of approximately equal amounts of normal and iso-butane. The error of analysis is shown to be 0.7%. In the second example shown in Fig. 4, a mixture was chosen where the propane constituent is abnormally high. This was done to demonstrate the ability to analyze for a small quantity of propane in the presence of a large quantity of butanes. The determination of the propane in this particular case was accurate to better than 0.1%. The probably maximum error for this determination at the present ime is between 0.2% and 0.3%.

To illustrate the third example outlined above, namely, the de-isobutanizer overhead and kettle products, two mixtures were chosen as shown in Fig. 5. In these analyses six runs were made on each mixture in order to show the close correspondence obtained on duplicate runs. The analyses of the kettle products give values of iso-butane concentration from 0.8% to 1.3%, a total range of 0.5%. The analyses of the overhead give values of normal butane concentration from 2.4% to 2.5% a total range of 0.1%. The maximum deviation between the spectrometer and the manometer determinations is 0.4% in the kettle products sample and 0.2% in the overhead sample.

The analyses considered so far are increasing in importance because of the growing demand for relatively pure propane and butanes which are required as the starting point of new synthetic chemical processes. Many such processes also require the analysis of mixtures containing olefines. Determination of the relative amounts of the various olefines in gas mixtures is often a time consuming and difficult process by the usual methods. In many cases a rapid and accurate method of analysis may be of considerable help, as for example in the establishing and maintaining efficient operation of polymer or alkylation plant for high octane aviation fuel.

During the course of our research work and purely on an experimental basis a sample with a composition typical of a polymerization plant feed stream was recently analyzed and the results are shown in Fig. 6. In this instance the complete C4 fraction was divided into five components, the trans- and Cis-2-butenes being lumped together. The largest error occurring in this analysis was 1.8%. This accuracy, in view of the similarity of the component gases in the mixture, compares most favorably with other methods that are available. The authors wish to point out, however, that the complete C4 analysis is still in the experimental stage, but it is hoped that it can be placed on a routine basis in the near future.

The size of sample required by this new method of analysis is relatively small. Only a few microliters of gas are passed through the instrument in the course of an analysis, but for convenience in handling samples, a few cubic centimeters of gas are ordinarily used. The small size greatly simplifies any transportation problems.

In addition to providing accurate analyses of small samples, the new method produces results quickly. Under our present laboratory procedure, the rate of analyzing samples varies from five to fifteen per day, depending on the information desired and the complexity of the mixture.

DE-ISOBUTANIZER KETTLE PRODUCTS

	Iso-Butane Percent	N-Butane Percent	Difference
Manometer	0.9	99.1	
Mass Spectrometer	1.1	98.9	0.2
	1.3	98.7	0.4
	1.1	98.9	0.2
	0.8	99.2	0.1
	1.2	98.8	0.3
	1.2	98.8	0.3

DE-ISOBUTANIZER OVERHEAD

	Iso-Butane Percent	N-Butane Percent	Difference
Manometer	97.7	2.3	
Mass Spectrometer	97.6	2.4	0.1
	97.6	2.4	0.1
	97.6	2.4	0.1
	97.5	2.5	0.2
	97.5	2.5	0.2
	97.5	2.5	0.2

POLYMERIZATION PLANT Feed Stream

	Manometer Percent	Mass Spectrometer Percent	Difference
Iso-Butene	14.4	14.1	0.3
1-Butene	16.7	14.9	1.8
2-Butenes	16.3	17.5	1.2
Iso-Butane	16.1	15.8	0.3
N-Butane	36.5	37.6	1.1

Fig. 6

The relatively short time required to make an analysis should be of considerable advantage in refinery control and for placing new plant facilities into operation. No attempt will be made here to point out the financial savings that might be effected, as this can properly be left to those who are more familiar with these problems.

It is largely because of the friendly urging by some of the members of this association that the new method is being made available on a laboratory basis at the present time, and the authors are most appreciative of the interest and cooperation they have received.

In conclusion, the authors wish to express their appreciation to Messrs. Wiley and Langmuir, and to the engineering and instrument staffs of the Consolidated Engineering Corporation, who have assisted in the experimental and development work; and to Miss Rock for assisting in the development of the mathematical procedure.

Natural Gasoline Plant Practice as Applied

To Cycling in High Pressure Pools

C. N. G. A. Fall, 1941

By P. C. Dixon
Foran, Boatwright and Dixon

It is hardly necessary to present a resume of the history of the art of gas cycling. In the Mid-Continent area, gas cycling has acquired sufficient background to become accepted as a standard means of production. Cycling in reservoirs similar to those found in the Mid-Continent is no longer experimental and its merits have been clearly demonstrated, even though the first plant to be placed in operation is now less than six years old.

In brief, cycling consists of producing high pressure wet gas through "output" wells, gathering this gas in a high pressure pipe line system and conducting it to the cycling plant, processing it in a fashion almost identical to that found in the average natural gasoline plant (except that the processing pressure will be approximately 2,000 lbs. per square inch), compressing the residue gas after processing and returning it to the same subsurface formation through "input" wells.

Operations of this nature may be conducted on fluids from reservoirs which contain substantially only a single (gas) phase material, or they may be conducted on fluids from reservoirs in which this single phase material exists as a gas cap over crude oil. In the latter case, the cycling operations may be confined solely to the gas cap material or it may include the production of quantities of dark oil and combine cycling and pressure maintenance operations. Any terminology descriptive of these combined operations is a matter of choice. A majority of the cycling operations to date have been confined to reservoirs containing predominately only a gas phase material. In many instances a relatively small ring of dark oil in permeable contact with the gas at the water table is found around such a reservoir; such oil is seldom profitably produced and, as a consequence, these reservoirs are commonly known as a single phase. Reservoirs of the second classification are seldom cycled because of the operator's desire to recover the dark oil in preference to the condensate, and more particularly, because of the fact that it is difficult and time consuming to properly unitize the mineral interests for the cycling operation.

The advantage of pressure maintenance in an oil reservoir have been well demonstrated, as have the advantages of cycling. In a combination reservoir (that is, a deep oil reservoir containing an appreciable gas cap), the reserve of greatest economic value is usually the liquid oil. As a rule, this oil is produced with a minimum of the gas cap material so that the expanding gas cap may provide energy to increase the ultimate recovery of dark oil. Such a gas cap undergoes a decrease in pressure during expansion and allows precipitation of valuable hydrocarbon liquids in the comparatively dry gas cap sand. Liquids precipitated in this manner are economically irrecoverable by production means available today. Cycling operations in the gas cap either before or during production of the dark oil will recover a major portion of the liquefiable constituents in the gas phase without removing the source of drive which may be obtained from an expanding gas cap. Since a cycling plant embodies substantially the same design and utilizes practically the same type of equipment found in the average natural gasoline or pressure maintenance plant, it is possible, for a reasonable additional expenditure, to provide facilities for gathering most of the gas produced with the dark oil and to process and recompress this gas and return it to the reservoir together with the gas from the gas cap. Thus, operations which are highly profitable to the operator and commendable from the standpoint of conservation may be combined in manageable form.

The cycling plant operator, in contrast to the natural gasoline plant operator, is usually both a producer and a manufacturer or processor; consequently, this paper will deal with over-all operations and will discuss production problems as they relate to plant operations.

Production Problems

Output and input well locations are influenced by several factors, including the following:

1. Geological requirements in definition of the structure.
2. Leasing and unitization requirements.
3. The efficient use of existing, exploratory and obligatory wells.
4. The efficient recovery of reservoir fluids.

It is important that proper consideration be given well locations in a cycling project because, as a rule, the economics of the over-all operations are such that excessive well investments may remove the profit from the venture.

The manner of completing wells used in a cycling project should be governed by the individual reservoir characteristics and by the use to which they are or may be dedicated. The casing, tubing and surface equipment should be selected only after careful study of the anticipated uses of the individual well. Casing size will depend upon the possibilities of deeper production and upon the use of the well for input or output purposes. Tubing is required in all wells to provide for proper well control. It is desirable to have a casing-tubing diameter ratio on output wells which will permit nonheading flow from the casing if the necessary flow from the well through the tubing results in flowing pressures below those at which the gathering system is operated. Assuming that two-inch is the minimum size tubing that may be used and that seven-inch is the largest casing desired in a well, the proper tubing diameter will ordinarily lie between two-inch and two and one-half inch.

Well head equipment on producing wells may be conventional. Well head equipment on input wells should be strong enough to withstand the anticipated input pressure applied as a shock load and the vibration to be anticipated when attached to the compressor discharge lines. When connecting up the bradenhead on both input and output wells, the maximum permissible stretch should be taken on the casing in order to minimize subsequent stresses resulting from the elevated temperatures to be expected under cycling operations.

Wells should not be accepted for plant use until they have been thoroughly cleaned of drilling mud, water and other debris. Every output well should initially be produced into the pits or field equipment at a rate at least equal to the maximum rate to be anticipated when the well is connected to the plant gathering system. Every input well should likewise be cleaned by flowing at the maximum safe rate.

The value of an output well to a cycling plant depends upon its ability to produce, against gathering line pressures, the quantity of gas necessary to provide maximum reservoir recovery for the cycling operation as a whole. The value of an input well is, more or less, in direct proportion to its flow potential which in turn is in proportion to its ability to receive dry gas. In order to maintain the original potential of an input well, it is necessary to protect the sand face from foreign materials which stop up the pore spaces and increase the pressure required to maintain gas flow into the formation. The three principal sources of these plugging materials are drilling mud, thread compound used in making

up the casing, and lubricating oil used in the compressors. It is good practice to use casting thread compound judiciously, water wash the casing thoroughly before bringing the well into production, and flow the well at high rates in order to eliminate water and drilling mud, and to use a relatively light oil for compressor cylinder lubrication. Facilities should be installed to recover the compressor lubricating oil from the high pressure gas stream.

Reservoir cycling efficiency is dependent upon many factors, including the following:

1. Well locations.
2. Gas withdrawal and input rates.
3. Continuity of the productive horizon.
4. Horizontal and vertical permiability relationships in the productive horizon.
5. The extent of competitive operations either by competitive cycling or by conventional production means without the return of gas to the producing horizon.

In part, the effect of the various factors enumerated may be studied by the use of electrolytic scale models. Such a study is desirable to determine the relative influence of the various factors before commencing operations.

The drilling, completion, and operation of the wells may be independent of the operations of the plant; when this is the case, the plant operator may or may not own and operate the gathering system and the input lines. The control of production from the wells and through the field lines should preferably be under the direct supervision of the plant officials whose operations are vitally affected by any field manipulations.

In some cases it may be desirable to sell limited quantities of dry gas. In this event, the plant operators should select the point from which this dry gas is withdrawn in order to minimize the upsetting effects of varying loads on plant operations, and so that relatively low pressure gas may be disposed of before being compressed to injection pressures.

The pipe line gathering system should have working pressures equal to the shut in pressure of the wells and the input line system working pressures should be equal to the shock input pressure. Each well connection should be securely anchored in concrete, or otherwise secured, so that line stresses due to expansion or line shock due to vibration, or failure by breakage, will not be transmitted to the well head connection. Expansion loops in the gathering system are sometimes necessary; a rule-of-thumb procedure is to install loops wherever the bottom hole temperature exceeds 175°F. Ground friction may prevent pipe movement in the gathering system when well head flowing temperatures are not excessive. The flowing temperatures are dependent upon the bottom hole temperature and the quantity and composition of fluids being produced from the well. Expansion loops are a necessity in practically all input lines and these loops should be laid in a horizontal plane to permit adequate support and to minimize vibration. All input lines and connections are subject to varying degrees of shock from vibration and pulsation. It is good practice to install suitable check valves on each input well and on the discharge header from the plant. Protective coal tar or asphalt coating on gathering lines or input lines is not particularly efficacious because line temperatures usually exceed the softening point of the coating material.

Organization

The problems which confront the Production Department in connection with a cycling project have been briefly outlined in order to show the close relationship that exists between the activities of the Production and Gasoline Departments when they jointly engage in cycling operations. Many decisions made by the Production Department are tempered by the various plant requirements; in order to achieve most satisfactory operations it is necessary that close cooperation exist between all parties responsible for the planning and operation of the entire venture.

Many problems confronting the plant operator are normally considered as production problems. The best practical results in operating a cycling plant are obtained when full control of all operations, including the wells and field line system, are under the plant superintendent or some other plant executive. Well repairs or the drilling of additional wells or activities of this nature may or may not be delegated as part of this responsibility, but this is immaterial provided proper consideration is given to the purposes for which such work is undertaken. In order to most efficiently discharge the responsibilities entrusted to the plant superintendent or executive officer, it is necessary that he be as familiar with the field and production problems as with the operation of the plant. In an average organization there may be few such men available. For this reason, cycling operations are under the supervision of the Production Department in some companies and under the supervision of the Natural Gasoline Department in other companies. The fact remains, however, that the only incentive for any form of business enterprise is the prospect of profitable operations, so that regardless of where jurisdiction may lie in the operation of a cycling project, it is proper that all of the resources, skill and knowledge applicable to the problem at hand be assembled and applied in the most advantageous fashion.

The Cycling Plant

In the past there has been a certain degree of secrecy connected with cycling operations, particularly with respect to plant operations. It is hoped that this paper may help to dispel this feeling. In the over-all plant extraction operations there are few fundamental differences that exist to differentiate these operations from those encountered in any well-operated natural gasoline plant. Two elements are introduced into cycling plant design that will cause little or no difficulty to most engineers; i. e., elevated pressure, and multiplicity of possible commercial petroleum fractions. A third element will enter in an important degree into the design of all high pressure equipment. This element has to do with the dense nature of the gases being processed and the relatively less dense nature of both the distillate which condenses from the reservoir gas and the absorption oil when it is in contact with the high pressure gas. If proper consideration is given to the above three elements, then details of the manner of processing or design may become as individual as they are in today's modern natural gasoline plant.

From the inlet gas header into the plant it is customary to successively reduce the pressure of the inlet gas to plant processing pressure, meter the gas, cool the gas by heat exchange with water to about 90°F., pass the gas through a scrubber and into the absorber from whence it passes again through a scrubber into the compressor suction; gas from the compressor discharge is conducted to the input wells through a conventional header and line system. While the above described high pressure gas flow may be varied, such variations accomplish approximately the same overall results.

The most satisfactory pressure and volume regulation at the plant inlet is obtained by choking the well flows sufficiently to control the fluid volumes from each well and then to make a final pressure reduction to processing pressure at the plant. In the event the shut-in pressure of the wells is in the neighborhood of 2500 pounds or less, the wells may be flowed directly into the plant, without mechanical pressure reduction other than line losses, and the processing pressure regulated only by the volume of intake gas supplied to the compressor.

In the Mid-Continent it is customary

to meter wet distillate gases either at the well or at the plant inlet with a conventional orifice meter and to calculate the flow using accepted orifice co-efficients. Metering in this fashion may not be accurate, because either at the well head or plant inlet meters the fluid which in the reservoir was single phase has now become two phase (gas and condensate) and the differential recorded on the meter may or may not indicate a correct flow. In order to compensate for this error, it is customary to assume that the gravity of the wet gas being metered is the same as the gravity of the single phase reservoir material. Gas measurements by this method have been found to be reliable when the volume of liquid is not in excess of approximately one gallon per m.c.f. It is considered good practice, however, to determine the actual volume of gas flowing through the plant inlet meter by material balance in the plant, and thus the volume of single phase gas can be accurately calculated and the proper meter factor established. It has been found that errors involved in metering a two phase material may not be the same for meters with flange taps as for meter with pipe taps. Errors introduced by this type of gas measurement are not appreciable and it has not been found necessary to install a scrubber ahead of each meter set in order to separately meter the liquid and the gas.

Incoming gas to the plant will increase in temperature during the first few days of operation as the wells warm, and will eventually reach a temperature of from 120 to 160°F. This warm incoming gas may be cooled in conventional tower sections or in shell and tube coolers to a processing temperature of about 90°F. at a nominal cost because of the high heat transfer rates that may be obtained due to the physical characteristics of the high pressure gas. Over-all heat transfer rates from water to gas at 2000 pounds of from 110 to 130 b.t.u. per square foot per degree F. are common.

The cool gas contains an appreciable quantity of condensates, both hydrocarbons and fresh water, and salt water may also be produced from the formation to contaminate the fresh water. In addition to the condensed liquids which are always contained in these distillate bearing gases, there may also be present such materials as drilling mud from the wells or other foreign materials which should not be allowed to enter the fat oil stream to be deposited in the low pressure processing system. All of the liquid or solid material should be extracted from the high pressure gas stream prior to entry into the absorber or oil contacting system. The liquids collected in the scrubber should be segregated and purged of all water and foreign solid materials before the condensate is allowed to mingle with the fat oil and pass to the heaters for stripping. The inlet gas scrubber has further uses such as the removal of crude or other colored oils which may contaminate the absorption oil, and the removal of hydrocarbon materials which have boiling points approaching the initial boiling point of the absorption oil. In the event separation of condensate is made for either of the latter reasons, the condensate so separated cannot be mingled with the fat oil and must be fractionated or processed separately.

The high pressure counter-current gas absorber is a slight variation of the customary low pressure absorber. Variation in its construction is made primarily to minimize the carry-over of oil particles whose density at high pressure in the absorber are not substantially greater than the density of the gas. A final scrubbing element may be built into the top of the absorber or it may be mounted independently on the ground, but such a final scrubber containing a high level shut-down device for the compressors is necessary. It has been found that, if the tower is operated at a maximum pressure to produce a gas free of absorption oil mist, a small rise in temperature or a relatively small change in the gravity of the lean oil charged to the tower may cause a sudden and upsetting surge of absorption oil into the scrubbing element. This latter action should not be encountered at relatively low pressures of from 1200 to 1500 pounds, but it is rather evident at a pressure of 2,000 pounds. In part the cause of this carry-over may be the rating of the absorber at its maximum working capacity of lineal velocity, in order to hold the vessel diameter to a minimum and thus decrease its initial cost. In one process in which the method of contacting the gas and the absorption oil does not follow the usual counter-current absorber flow it is possible to construct a high pressure contacting unit with a capacity of 100 million cubic feet of gas per day using vessels with a maximum diameter of 30 inches.

The compressor suction and discharge headers are subject to more intense vibration than that encountered at lower pressures, due to the high density of the gas and its greater capacity to carry sound. All pipe should be so anchored in place that vibration is minimized or mitigated in order to escape fatigue stresses.

The absorption oil cycle and the various product streams in the low pressure system may be identical to that in use in a typical natural gasoline plant. The lean oil is charged to the absorber or contacting system by a steam or power driven pump. The fat oil is withdrawn from the absorber or contact system and flashed in one or more stages of pressure reduction to the desired low pressure required for stripping. Conventional heat exchange is provided and a final high heat supplied by steam preheaters or by a gas fired heater, stripping is effected by the use of open steam in a steam still in the former case and by flash directly into a fractionator in the latter case. The lean oil completes its cycle through the heat exchangers and into a lean oil accumulator while the products of distillation are segregated as may be desired.

Practically all types of lean oil charge pumps have proved satisfactory in operation. The power driven plunger pump is probably the least flexible of all types of drive, but in many cases its use is justified and desirable. Direct operated steam pumps, particularly of the twin simplex type with two stages of steam expansion are economical and very flexible. Turbine driven centrifugal pumps may be found more satisfactory than either of the other two types mentioned if the initial cost can be justified.

The fat oil withdrawn from the high pressure absorber is in most cases flashed directly down to some pressure in the neighborhood of 300 lbs., in which event the gas from this flash operation may be passed through the low pressure reabsorbed into the plant fuel system. Gas produced as a result of the flashing operation may be excessive if the reservoir fluid is rich in propane and butane and suitable disposal or utilization of the flash gases should be arranged. If the volumes of flash gas are excessive, it may be desirable to install an intermediate stage of flashing at a pressure of approximately 1,000 lbs. The gases evolved in this stage of separation may be economically returned with one stage of compression either to the input line header or back into the high pressure absorber inlet for recycling.

A difference of opinion will probably exist as to the appropriate use of steam or of gas fired heaters to effect stripping of the fat oil. The products that may be obtained from distillate gases range from natural gasoline fractions to and including an oil fraction equivalent to absorption or furnace oil. Stripping the fat oil of the higher boiling point materials by the use of steam not only requires large quantities of steam, but it also requires relatively high steam pressures. The appropriate form of heating will be determined by the type of finished products desired and, to a certain extent, by the type of boilers installed, and by other considerations which are dependent upon over-all plant design. In

general, the economy of gas fired heaters is in direct proportion to plant capacity. The oil heaters and heat exchangers are conventional except that, due to the low oil rate, they will be relatively small in size.

Some cycling plants produce finished products that range from propane to furnace oil and may include a specification gasoline. Equipment which may be used in the manufacture of the various products need not be described in this paper because there are no unusual features either in its design or use.

Safety in Plant Operation

Certain unusual or special safety problems arise in the operation of any type of high pressure extraction unit. Most of the safety problems stem from the fact that only a part of the operations are conducted at pressures which are essentially hazardous and that there must be communication or close relationship between the high pressure units and the various low pressure units. As a rule the parts of the plant which operate at elevated pressures are connected to the low pressure processing unit by means of a fat oil discharge valve and line through which is released the fat oil from the absorber to a low or intermediate flash separator. In the event the valve discharging this high pressure oil operates in any but a throttling position, it may discharge dangerously large quantities of oil and gas into the low pressure unit; further, if this valve should fail in its operation and lower the liquid level to a point at which gas alone passes through the valve, a hazardous situation may be created in the low pressure unit. The precautions which may be taken in order to minimize or eliminate these hazards are more or less self-evident, but it should be recognized that the high pressure valves and controls are capable of dicharging both gas and oil, where the gas may be in solution in the oil or may exist as free gas, to the low pressure unit in quantities that are unbelieveably large.

A further safety problem merits attention in connection with the low pressure processing units, which is not covered by common experience in present day gasoline plants. This problem has to do with the relative locations on the ground site of the four groups of equipment which in general are as follows:

Group 1: The high pressure processing equipment, including the lean oil charge pump and the compressor for returning dry gas to the input wells.

Group 2: The distillation equipment which includes all heat exchangers, preheaters, fractionator and stabilizing columns, and oil accumulator tanks.

Group 3: All open flame devices such as the boiler plant, the electric generator and the gas fired heaters.

Group 4: All run tank and other forms of storage for manufactured products.

Grouping of the equipment in compliance with the minimum standards of the Oil Insurance Association is not sufficient in all cases to provide practical safety in operations. It is thought to be essential that the items of equipment listed in Group 3 be located in a direction from the items listed in Group 1, such that, if possible, the wind directions from the Group 1 equipment towards the Group 3 equipment is minimum with respect to all other probable wind directions. One of the greatest hazards observed has been the occurrence of leaks on the high pressure processing unit at points below normal oil levels, or at places where a mixture of oil and gas may be discharged through the leak. Fluids discharged through relatively small orifices or leaks at high pressures are so finely dispersed that the escaping material has much the same appearance as steam. The liquid in such a discharge is so finely disseminated that it does not readily settle to the ground but floats for great distances before settling and removing the hazard of contact with open flames. An example of such a leak is that which may occur by a gasket failing on a reflex gauge glass. The breakage or failure of any part of the equipment attached to the high pressure unit results in the discharge of tremendous quantities of either gas or liquid; the hazards inherent in these discharged fluids must be recognized.

The location of Groups 2 and 4 with respect to Group 1 is thought to be more or less immaterial, except that, as a minimum, the Oil Insurance Association's recommendation should be followed.

Selection of Material

The working pressures encountered in the design of a cycling plant may range from 100 to 4000 pounds with the result that limited quantities of practically every grade and classification of fitting may find usage. Assuming that no grade or classification of fitting is used for a working pressure in excess of its proper rating, some very small savings in material purchase may be made in the original installation by making full use of the wide selections made available by the manufacturers. The many selections available are probably best typified in flanges. Here the several standard weight flanges may be re-rated on the basis of flange material. Experience dictates that as few grades and materials should be used in plant and line construction as is reasonably possible, in order to facilitate later plant maintenance and avoid construction errors that might create hazards. For example, an entire plant with its pipe line system may be constructed using Series 1500 ring joint and Series 300 and 150 raised face flanges, or the same plant may be constructed at an infinitely small saving in material costs using Series 1500 and 900 ring joint and Series 600, 300 and 150 raised face flanges.

Pipe should be as nearly standardized as possible, a recommendation being made that all pipe be seamless, or its equivalent, in as few weights as may be reasonable. For example, if three inch Schedule 120 pipe be used in the plant gathering system there preferably should be no three inch extra heavy pipe or welding fittings specified for plant use. In this latter case the insignificant quantity of three inch extra heavy pipe and fittings that might be used in the plant on the high pressure processing unit at a slight saving in cost over the use of three inch Schedule 120 does not justify the contingent hazard of the erroneous use of one extra heavy welding fitting in the gathering line system. It may be desirable to use Grade C line pipe in some sizes and in this event suitable precautions are necessary in order to distinguish Grade B pipe and fittings of the same size and weight.

The use of 72,000-75,000 pound tensile strength steel for plant vessels has probably received a set-back due to the existing situation in steel plate. However, weldable steel of maximum strength is preferred in vessel fabrication in order to decrease wall thickness and thus increase the usable diameter.

Codes and standards of practice in the rating of equipment for use in gasoline plants and refineries are well known and ordinarily followed by the industry. In elevating the processing pressure and working more closely to the field production it will be found that discrepancies exist in the application of ratings to such an extent that the problem merits some discussion. For example, the plant operator in constructing his field lines may use Series 1500 Class 2 forged steel flanges and consider them safe for a maximum working pressure of 3000 lbs. In making connection to the christmas tree of a producing well, it may be found that the flanges considered safe for operations at 3000 lbs. pressure are Series 900 alloy cast steel. Manufacturers of certain types of equipment are outspoken in their opinion regarding the conservative rating of flanges and may furnish, unless otherwise instructed, special forged steel flanges which, size for size, are only a fraction of the weight of a standard A.S.A. flange for the same working pressure. Various manufacturers recommend the use of electric cast steels for cold working pressures rang-

ing from 1000 to 2000 lbs. In some cases 100,000-lb. tensile cast steel is recommended for use in and about the plant at pressures up to 2500 lbs., the same material being furnished for wellhead fittings rated for a working pressure of 5000 pounds.

Needless to say, some consistent design should be carried throughout the entire cycling project. If it is found suitable to use pipe with an ultimate bursting strength of three times the working pressure in the wells it may not be consistent to use pipe with an ultimate bursting strength of four times the working pressure in the field lines.

As a further insight into the more or less disproportionate factors of safety which are encountered in design work, it may be proper to raise the question as to the necessity of a factor of safety of four in the design of the high pressure processing equipment. Assuming that proper corrosion allowance is made in all vessel design it is not unreasonable to specify 1200 lbs. or higher as the ultimate bursting strength for a vessel to operate at 300 lbs., particularly when this vessel is connected to a source of almost unlimited energy such as the high pressure processing set with its 2000 lbs. of gas pressure. On the other hand, the high pressure processing vessels are customarily connected to wells whose shut in pressure may be in the neighborhood of 3000 lbs. In the event of total failure of all controls and an equalization of pressure directly from the well to the outlet of the high pressure processing unit, the maximum pressure that can obtain will be 3000 lbs., or one and one-half times the designed working pressure.

It does not seem proper at this time to express an opinion regarding the reasonableness of customary design. The combination of the production problem, together with the processing problem in cycling, does however force a contrast between the existing methods of procedure. We may find occasion to view rather critically the combination of codes and usages which we are bound to respect.

Selection and Care of Absorption Oil

The selection of an absorption oil for certain desirable characteristics is well known. Relatively few years ago it was thought that operating pressures in excess of approximately 1000 pounds would never be practical in commercial plant operations. Experimental work, however, indicated the fact that such was not the case, but it was early recognized that even in the lightest or leanest of distillates there were certain materials which had boiling points in common with some parts of the absorption oil. In the early work, then, it was preconceived that it was not feasible to use an absorption oil not native to the well effluent because of conflicting boiling ranges. Since the early study, however, it has become clear that certain portions of the well effluent may be extracted before coming in contact with the absorption oil. This makes possible the use of oil of such characteristics that its absorption of the lighter and less desirable gases is a minimum while its affinity for the heavier and desirable constituents is maximum. By the use of such a special absorption oil we may minimize the amount of undesirable flash gas that must be returned to the formation due to the oils selective absorption characteristics and the relatively low oil rate which may be obtained. The purchase of such an oil may not be justified at present day processing pressures. However, with certain types of contacting processes there is to be found no pressures up to 3000 lbs. which, under certain circumstances, are not only economical but also efficient for absorption operations.

If the absorption oil is contained in a closed circuit without refreshment in material quantities it is customary to rerun portions of the oil continuously or from time to time, whereas, if the absorption oil is composed of portions of the well effluent there will be a continual production of this absorption oil so that the circuit is open and continually refreshed and re-running is not necessary. The use of certain types of lubricating oils is to be avoided in the event the absorption oil system is a closed one, for the lubricating oil applied to the packing of pumps finds its way into the absorption oil stream with possible harmful effects.

The Natural Gasoline Industry

and National Defense

C. N. G. A.
Fall, 1941

During the week of August 16, 1941, the Petroleum Co-ordinator for National Defense called upon the petroleum industry to treble its capacity to produce 100 octane aviation gasoline.

And on August 25, 1941, in his Recommendation No. 8 the Petroleum Co-ordinator for National Defense recommended that members of the industry manufacturing 100 octane aviation gasoline cease using blending agents of a petroleum origin except for the production and manufacture of 100 octane aviation gasoline.

You, who manufacture natural gasoline recognize these statements of the Petroleum Co-ordinator as a challenge and a duty laid upon the natural gasoline industry to take a "seat down front" immediately so far as the defense program is concerned. Not only can natural gasoline directly contribute to the manufacture of high octane aviation gasoline but when natural gasoline is blended to produce motor fuel, it releases other blending agents for use in the manufacture of vital 100 octane aviation gasoline.

But this is only a small incident in the defense drama. Defense demands that there be no waste of petroleum and petroleum products. Defense demands that every iota of energy be squeezed from our great natural resources—from petroleum, from natural gas, from natural gasoline, from the liquefied petroleum gases. The natural gasoline industry by virtue of its experience, its equipment, its present manner of operations, is able to contribute a great deal to meeting these defense demands. We know how to use efficiently and profitably the by-products, the derivatives of petroleum and natural gas which would otherwise go unused or be wasted. In applying this knowledge the natural gasoline industry will play its part in an "all-out" defense program.

The Petroleum Co-ordinator has recently established a Natural Gas and Naural Gasoline Section. The duty of this Section will be to co-ordinate the activities of the natural gas and natural gasoline industries with the defense program. We, the industry, have been called upon to serve in that Section. We, the industry, have accepted proudly and willingly because we know that as natural gasoline manufacturers, we shall be able to bring to the aid of this great defense program the united efforts of an industry whose patriotism is unquestioned and whose technological and scientific ability is without equal on the American industrial scene.

In the broad general defense program natural gasoline and the natural gasoline industry will play an integral part. Primarily, defense requires our co-operative and co-ordinated effort to manufacture and make constantly available a steady stream of hydrocarbon products to be used to meet defense needs and essential

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Speech delivered by Paul M. Raigorodsky, Assistant Director of Production, in Charge of Natural Gas Section, Office of Petroleum Co-ordinator for National Defense, before the California Natural Gasoline Association, in Los Angeles, California, on October 31, 1941.

civilian uses. Your knowledge, your advice, your fullest efforts are needed now to contribute to the success of an "all-out" defense effort.

Let us be specific for a moment.

The importance of the natural gasoline industry has long been recognized by those who have been familiar with it. However not until recent years have those who thought of oil in a national sense concerned themselves with natural gasoline. In its early days it was looked upon as a scavenger in the oil industry because it drew its raw material from the waste in crude oil production. It has suffered more from price fluctuation in the past thirty-odd years than any other petroleum product. Even as late as 1940 it sold at only 6 percent of its 1919 market price, although the quality of the 1940 product was infinitely superior to that which was produced and sold in 1919.

Today's production of natural gasoline of some 165,000 barrels per day represents nearly 10 percent of the total production of gasoline in the United States. In that respect it is an important source of moor fuel and should be recognized as such. However, impressive as are these figures when it is considered that this production comes largely from an otherwise wasted raw material, mere quantitive relationships do not reveal the whole picture. There are subsidiary relationships of at least equal importance which must be considered.

Natural gasoline as such, when blended to produce motor fuel is 100 percent usable as fuel without further processing. It would require 7,000 wells each producing 40 barrels a day to produce the 275,000 barrels of crude oil required to displace this amount of gasoline, if the highest yield of any refining district were used as a basis for the calculation. It would cost a quarter of a billion dollars to drill the required wells and provide refining capacity for this additional crude oil. Natural gasoline production, therefore, conserves this crude for future demand.

Natural gasoline plays a substantial part in imparting the volatility required and desired to assure quick starting and acceleration of motors. Substantial quantities of light fractions are now produced from cracking gas oil and topped crude at refineries, but considerable more cracking or reforming would be required to provide a substitute for the natural gasoline now manufactured and used in motor fuel; and in the process substantial quantities of crude oil or naphtha would be converted to gas. It is evident, therefore, that natural gasoline does not simply provide a substitute quantity of motor fuel, but provides special volatile fractions which are more costly to produce at a refinery than ordinary motor fuel when it is produced as an end in itself.

Because the octane number of standard motor fuels has been stepped up from year to year, the use of high octane natural gasoline does not reduce the cost of building high octane into motor fuels in the same proportion as it did in an earlier day. However, although refiners purchase natural gasoline with an eye to octane improvement, they realize that it is not alone the octane blending value of natural gasoline which must be taken into account, but the increase in lead suscepibility or lead responsiveness which materially reduces the quantity of tetra ethyl lead required to blend to a given octane standard. In terms of total tetra ethyl lead industry-wide savings, if all natural gasoline were used in leaded fuels we can set down the imposing figure of some 10,000,000 c.c.s of tetra ethyl lead per day. From an overall national standpoint this represents a substantial release of essential chemicals with no detrimental effect upon the quality of the fuels produced.

A development of the past several years is the production of 100 octane aviation fuel by alkylation. In a typical alkylation process concentrated sulfuric acid is employed as a catalyst to alkylate isobuane with butylenes. Butylene is a product of the cracking still in the refinery, but while some iso-butane is produced from the same source and from the crude oil processed in the plant, the main source of iso-butane is the natural gasoline plant.

In the recent past, gasoline plants as a whole extracted iso-butane in a butane-iso-butane mixture in excess of what was required to produce natural gasoline, only when they had a market for that product. The price was exceedingly low. The advent of alkylation and related processes stimulated the demand for iso-butane and increased its production. In a number of gasoline plants, where analysis showed commercial quantities of this hydrocarbon, facilities were installed for its extraction and separation. Prices for the product have averaged from two to three times the price of normal buane.

The isomerization and dehydrogenation of butane into iso-butane, however, will tend to decrease this ratio in proportion to the percentage of conversion less the cost of processing. It will also increase the use of butane for the benefit of the National Defense while making more room for the use of propane as a fair substitute for the numerous uses of butane at the present.

Generally speaking, it may be said that the provision of facilities by the natural gasoline industry to provide these essential raw materials in the past has kept pace with National Defense and demand of refiners. The time required for the building of extraction facilities is incomparably shorter than that required to design and erect the complicated and expensive conversion processes at the refinery. For this reason the refiner may count with certainty upon his source of supply of iso-butane, once he has made provisions to secure it, and may proceed with confidence with the erection of alkylate and similar manufacturing units.

The manufacture of aviation gasoline by the several available alkylation processes, not to mention at least two other methods developed by several outstanding refining companies, is one of countless examples of the ingenuity and skill of American technologists. The development of these methods of production of aviation gasoline, as well as the perfection of several polymerization processes to produce high anti-knock motor fuel from refinery gases and natural gasoline plant "waste" gases, not only represents important accomplishments in the prevention of waste by converting low value fuels or wasted gases into valuable components of motor fuel, but the timing of the development fits adequately into the greatly expanded needs for high octane aviation fuels for the defense needs of this country and for those of the nations which the United States is aiding.

It is tentatively estimated that over 35,000 barrels a day of Butane can be made available in the natural gasoline industry for dehydrogenation or isomerization without substantial expenditure on the facilities for its production.

This volume combined with available iso-butane would produce almost 50,000 barrels a day of alkylate of 94 octane. Assuming a blend of 60 percent of alkylate with 40 percent of aviation straight run of 70-74 octane and some iso-pentane it may permit manufacturing of 80,000 barrels a day of 100 octane aviation gasoline (with 3c.c.s Pb).

Figures need not be cited to reveal the extent of this country's aviation gasoline production, present or contemplated. In all efforts to increase this production, the suppliers of iso-butane and butane have played an important part. They have made their products accessible first by providing extraction facilities and second by transporting it by rail, pipe line, truck and tanker. The end of the supply is not in sight.

Natural gasoline is performing yet another direct service in extensive efforts at increase of aviation gasoline production. Butylenes and iso-butane removed as components of refinery motor fuel for their use in synthesizing the high octane fuels required in or as aviation gasoline, create in most cases subnormal vapor pressures in the remaining motor fuel

stock. Natural gasoline or butane or both may be and are employed to restore or impart the volatility characteristics necessary for the "balanced" motor fuel.

Conclusion

The natural gasoline industry faces a challenge and a hope. The challenge is production for defense. The hope is the profitable future of our industry in the peace of tomorrow. If we meet the challenge, we will fulfill the hope because meeting the challenge means not only improving our methods of manufacture, transportation and sale but also opening up new and fertile uses for natural gasoline and other hydrocarbon products.

It is our solemn duty as Americans—as patriots, to meet the challenge with every ounce of our creative, scientific, technical skill and managerial ability. It is to our advantage as natural gasoline operators to employ our resources to the end that our products shall have greater utilization.

No one can deny our high degree of scientific skill. No one should be able to question our patriotism in applying that skill to the urgencies of defense. No one will begrudge us our reward for our share in the defense program when that reward takes the form of bringing to the public new and valuable hydrocarbon products at reasonable prices.

Again I say our industry faces tremendous responbilities and great opportunities. Let us work—hard, long hours—to meet these responsibilities and avail ourselves of these opportunities.

I know you join me when I say we of the natural gasoline industry can and will fulfill all demands made upon us by the National Defense Program—and then we will do more!

Human Engineering in the Petroleum Industry

C. N. G. A.
Fall, 1941

By Geo. P. Bunn and Wallace Williams
Phillips Petroleum Co.

Considerably less than fifty years ago not much was heard of the petroleum business; the finding and production of petroleum in those days was generally referred to as "the oil game". When one spoke of "the oil game" he meant exactly that. The discovery and production of oil and the manufacture of petroleum products were pretty much hit or miss propositions. Every move in connection therewith was a game of chance, each operator pitting his nerve and luck against those of his competitors. Decisions more often were made on the basis of hunches because of the limited technology available. Such were the necessities in coping with the little understood secrets of nature in a pioneering industry very much in its infancy. Today, still a young, live, vigorous industry, it is progressive, guided now by scientific rules derived from exhaustive research built upon the practical experience so painfully accumulated by its founders over the earlier years. Now that industry has found itself, in its course, advancing and development of the automobile and the airplane and leaving its unmistakable but often overlooked impression on almost all business. Few industries today produce products of greater value or attract more or better talent than this oil industry of ours. Each year engineering graduates from colleges and universities of the world pour into oil industries by the thousands to study and improve upon every feature of oil and gas from the time they leave the ground until reaching the ultimate consumer. During recent years these technicians have greatly extended our services to the nation, improving productive and analytical methods, bettering the quality of products, discovering and perfecting manufacture of valuable by-products, opening new fields and extending old ones for the use of petroleum and its derivatives. Their efforts have created thousands of new jobs and have made easier and more pleasant the living of all of us. The production of petroleum and its ever increasing products presses on, ably aided in every direction by engineering.

Introduction to Human Engineering

Your programs are recurring replete with technical papers and discussions concerned with the physical problems of the industry of which our natural gasoline business is a part. It is through such conferences, in fact, that progress, industry-wide, comes. It is not our purpose today, however, to consider scientific advancement in this direction. Instead, let us deal with another field in which the industry has made marked progress and to which constant study is directed for further advances. This field is often and appropriately termed "human engineering" in the petroleum industry. Engineering of manpower in this industry, directed alike to the improvement of superiors and workers, has made for better effort, better products, better understanding and more wholesome living. Consider, for a while, the methods and the results of human engineering in the realm of oil.

Recognition of Technique

Leaders in the industry early recognized and accepted obligation to their employees as well as to the community of citizens as a whole. Just as there is necessity for furnishing a trade territory with the finest products, the need for developing employees, not only as good workers but as assets to their communities, was acknowledged. It was not long until careful engineering studies of problems of personnel were undertaken. Steadily and assuredly the petroleum industry has been a pace-setter in striving for improvement of man-power among all its workers, growing from some 45,000 in 1880 to about one and on-quarter millions in all its branches at present. Long has the oil business, the employer of perhaps the most independently operating agents in all industry, attracted intelligent, daring, ambitious forces, who preferred this work to less adventurous professions. Aside from the romance of oil which, of itself, will ever be a challenge, undoubtedly this preference was brought about by the attention of the leaders of the industry to the development of a scientific procedure in guiding the welfare of employees. The mechanisms for oil and gas mining are ponderous and rugged. They seem to operate forcefully through sheer weight and raw power rather than through skillful planning and technique. Those who have discerned no finesse worthy of the term "scientific procedure" in the development of human relations in the petroleum industry, may, on closer examination, note that the approach was more often as starkly realistic and direct as the mining methods themselves and none the less scientific. The industry could not have become—could not be—what it is today without closest teamwork of boss and worker, sweating shoulder to shoulder. Such intimate contact could not but have developed the fullest understanding as a valuable bequest to the present, even though some of the leaders seem now a long way removed from the sphere of the tour man.

Elements of Living

There are certain fundamentals which are vital to the well being of every individual, be he laborer or executive. To the greatest enjoyment of living many other factors contribute, some of them in accordance with individual effort and preference, some attained to best advantage through cooperative effort. Obviously, of first consideration to every man

are food, clothing, and shelter for his family and himself. Workers of the petroleum industry are envied by those in many other occupations because our employers have perennially been leaders in affording a rate of regular employment equalled by no other of the greater businesses of the nation, and annual rates of pay are seldom, if ever surpassed. These alone establish the first foundations of security. Living conditions in the oil fields, necessarily rural in so many regions, after years of progress have greatly improved for the greater numbers. Employers have constructed neat, comfortable cottages for many of their workers in the remote areas supplying fuel, light and water, at costs less than average for comparable homes elsewhere. Others have provided ground upon which employees may build their own homes, usually improving the plots with sewage, water, fuel and light facilities. All such provisions add materially to the real wages of the oil trades and raise the standard of living to that of any other section of the country. Travelers often remark at the neat field camps, with their flowers and gardens, so often seen in any oil producing state, and at the many fine school buildings of brick or native stone, with their modern facilities and conveniences. The excellent educational facilities are largely provided from the taxes on oil, and moreover petroleum leadership often actively promotes and advances such projects, assuring educational advantages even better than the average of their localities, for the children of its workers.

Refinements of Security

To these fundamentals of successful living, an increasing number of employers are adding other features of security. The need for relief in sickness, accident and death has not been overlooked. Too often do such emergencies wipe out the careful savings of months of thrift, confronting families with hardship and debt. So that each employee may fortify against such hazards, progressive concerns have arranged various types of security programs in which employees may participate. Some have established provisions under which an employee, according to length of service and period of disability, may receive, at his employer's expense, varying proportions of his regular wages during sickness or off-duty accident. Others have arranged for group accident and sickness insurance whereby at low, quantity rates the employee, with no great sacrifice, may be protected. Many such policies carry surgical benefits and others, for small additional premiums, provide for hospitalization of the worker and every member of his family. Most concerns now have group contracts with insurance underwriters under which employees are provided life insurance, in some cases at the employer's expense, in increasing amount according to length of service; in other cases at small cost to the employee in amounts he may elect. Even before federal social security provisions, and now supplementing those benefits, old age retirement plans have been taken up by more and more of the petroleum industry. It is a pleasure, indeed, to see a group giving a farewell party to a fellow employee who, after many years of service, steps out with a comfortable provision for all his remaining years. These are just a few of the actual security programs effected throughout the entire petroleum industry for the benefit of all the workers. They are all practical and have definitely demonstrated their value to both employee and employer. While not all concerns have found ways and means of applying such human engineering, limited records available seem to indicate more units of this industry than of any other have taken up such measures.

Development of Safety

While provisions for sickness and accident benefits are in the ascendancy, efforts toward the promotion of health and safety in our operations are of longer standing. In spite of the continuing hazards in dealing with the products of this industry safety measures for accident prevention have produced a steady decrease in lost-time injuries. The technical approach to these problems has resulted in improved equipment, mechanical safeguards, protective laws and regulations, and, most important of all, a fine teamwork among the workers themselves. Practical, first-hand observation of the men engaged in actual operations has time after time furnished the suggestion or the clue to the elimination of hazards. Regular safety meetings, directing a continued attention to the problems of accident prevention, have resulted in the safety-consciousness indispensable to the program. The cold figures of the statistician prove we are now safer on the job than on the highway or even at home. Such a record is a tribute to the superb, combined accomplishment of employees, engineers, and management.

Training for Improvement

Another most constructive bit of human engineering in the petroleum industry has produced a profound, beneficial result in a comparatively few year. The desire to improve is a characteristic trait of the American people. A typical American strives to learn everything he can about his job, his trade, his hobby and even of endeavors outside his normal environment. Having mastered his job the alert, ambitious man seeks ways to improve upon it. Overwhelming response to provisions for formal training of oil workers for better understanding of jobs and preparation for advancement has proven the soundness of these observations. A brief glance at the published annual records alone will convince, even though it must be realized that such figures are far from complete. Note some of the types of training used. Many concerns route newly engaged engineering graduates through regular operating jobs for a knowledge of the rudimentary mechanics, and with what result? The young man and the wise operator have exchanged secrets to mutual advantage, the one as much the teacher as the other. Departments of trade and vocational education of practically all the oil states, collaborating with the petroleum industry in its various branches and usually with federal participation and assistance, are regularly offering night class instruction in subjects contributing to individual advancement and industrial improvement. Text books have been especially written for many of these courses and thousands have completed the required studies. Previously denied the benefits of particular industrial education, many, through a related series of such classes have received quite comprehensive training in the fundamentals of their business. Employers themselves, as their resources permit, often exclusively undertake extensive education of employees or supplement the efforts of the states. The advanced training of foremen and supervisors has been particularly beneficial to human relations in the field of oil. Employees trained through all these means begin making valuable suggestions for improvement of practices and as a result the "suggestion box" at many plants now solidly established, yielding ideas of originality and ingenuity and bringing rewards to the contributors. Such use of leisure time, although of greatest importance, is only one of the interest outlets available to the oil worker. Opportunity for home, camp and communiy improvement and beautification; thrifty cooperative gardening, cooking, and canning projects; organized picnics and other outings; community center social gatherings and entertainments; clubs; service organizations; recreational and competitive athletics,—all these in most cases initiated by employers and thereafter carried forward by employees, especially among the rural oil populations,—are adding greatly to the breadth of living and fixing patterns to emulate.

Scientific Foremanship

Heretofore we have mentioned schooling of foremen as well as artisans. Let us now emphasize training for foremanship. From the experience of at least a

century has been gleaned a wealth of the best in corporate leadership in an industrial world. Every progressive management of the larger units of industry has longer than lately realized that not only continuing business harmony but also advancing business success depends upon capable foremanship to whom leadership must be delegated. It is the law of modern business, furthermore, that a good foreman is not to be a hard-fisted taskmaster but a dependable, trained leader, learned in his responsibilities, skillful in applied psychology, human in his understanding, motivated not alone by the requirements of the job for the day but also by an appreciation of the faculties and the conditions of living, working, and development of his co-workers who are necessary to accomplishment. Through periodic conference, often initially led by representatives of state and through regular training classes, the oil industry is now seeking to improve older foremen and to prepare younger. By such courses the sound experience of the past may be reviewed, emphasized, adapted, and the regard and interest of management for its employees may clearly and repeatedly be delineated. Perhaps no other single effort in human engineering has been so effective and forceful in making the petroleum industry—an industry of wide spaces and greatly dispersed effort—the truly democratic business it is.

Philosophy of the Future

Not all units of the petroleum industry have progressed through all the steps we have mentioned but there continues a gradual cooperative improvement in that general direction. Analysis of each environment dictates the wisest moves for well being of employees in a particular situation and many an oil concern has established most impressive and productive programs. We have mentioned but a few of the measures taken. To individual aptitude measurements guiding employee placement; thrift,, savings, credit, mutual benefit and bonus plans promoting employee independence; periodic medical examination and immunization leading to health improvement; employment record systems assuring credit for all service rendered; service emblems in recognition of long and faithful service; employee news publications for continuing community of interest among all the members of a ornganization; may be added a great many other suggestions for carrying out real programs of human engineering in the petroleum industry. The alert, progressive employer long since wisely observed, through application of simple fundamental engineering analysis, that it paid in less lost time, in lower labor turnover, in better product turned out by increasingly skillful, worry-free employees, in the creation of greater buyer power, in the attractioon of favorable, respectful trade and in the attainment of profits for industry to constantly add to advantages and benefits of he worker. How can we further explore the avenues of human engineering to utilize to the fullest the many mutual benefits which we know lie within our reach? The solution will develop clearly cut and unmistakably whenever both employer and employee realize that neither can travel his own separate way heedless of the direction of the other. There has never been, can never be, but one path, broad, smooth, and straight for both to travel together. All by-roads are but detours which inevitably grow more rocky the further we travel them, ultimately leading astray and impeding progress toward desired goals. It is a happy day when the proprietor learns his natural, humane, unselfish impulses and the desire to advance his business and his income may at one and the same time be satisfied in a program of improvement for his employees. And wise, indeed are the employees who, noting their employers' efforts in this direction and participating in the benefits, show due appreciation and cooperatively respond to the end that the living of every worker, not only in oil but in all industry, will be similarly improved. Thus our country through amicable, voluntary means, and not through strife may become a still better place than any other in all the world in which to live.

The Partial Volume and It's Significance

C. N. G. A. Fall, 1941

B. H. Sage and W. N. Lacey
California Institute of Technology

ABSTRACT

The physical significance of the partial specific volume is discussed in some detail with especial reference to the concept of variable weight systems. The methods whereby the partial specific volume may be evaluated from experimental data are described and several applications of this property to the solution of industrial problems relating to systems of variable weight are indicated.

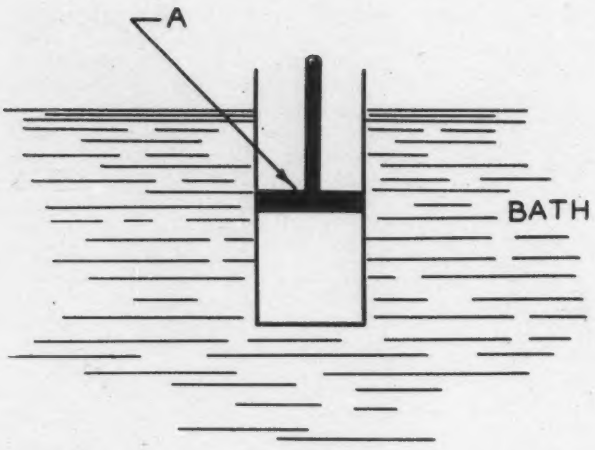
In many of the industrial operations encountered in the petroleum industry, it is of importance to predict the specific volume, or its reciprocal the specific weight, for a particular mixture at a given temperature and pressure. During the last decade a great deal of effort has been expended both in the accumulation of the necessary factual information relating to hydrocarbons and in the correlation of these results so that they might be of value to the practicing engineer. Among the various methods that have been proposed for the correlation of the behavior of hydrocarbon mixtures, the use of the partial volume (1) has been suggested (2). It is the objective of this discussion to describe the significance of the concept of a partial volume only with regard to its application in industrial calculations and not to attempt to indicate the more general utility of such concepts.

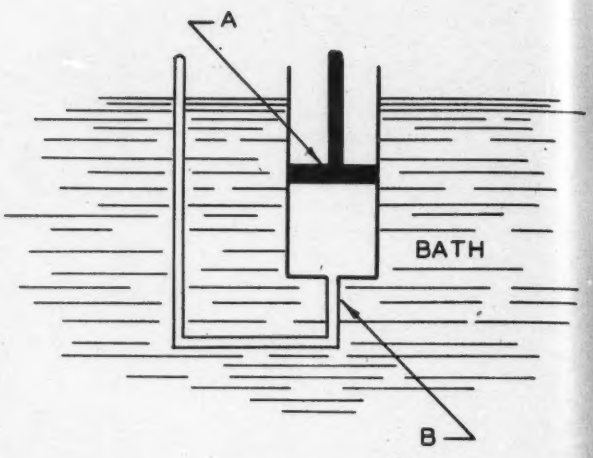
Theoretical Consideration

The state of a particular quantity of material is said to be fixed when its intensive properties do not change with time. The engineer commonly employs pressure and temperature as independent variables, since these are most readily controlled. In the petroleum industry the composition of a mixture is frequently ascertained in terms of the mole fraction or of the weight fraction of each of the lighter paraffin hydrocarbons together with the fraction of the components of higher molecular weight taken as a group and described by one or more suitable characterization factors. By use of this device for expressing the nature of the material the state of the hydrocarbon mixture may often be expressed in terms of its composition and the prevailing pressure and temperature. Although this is sufficient to ascertain its state, it still is necessary for engineering purposes to determine the quantity of material involved.

A system made up of a body of material within a closed container of variable volume is portrayed in Figure 1. This system may be immersed in a bath whose temperature is controlled in any way desired. If the temperature is kept constant any equilibrium changes occurring within the system will be isothermal processes. The volume may be changed by movement of the Piston A. The pressure may be varied only by suitable manipulations of the volume and the temperature. This system is characteristic of those classifed as constant-weight systems. Since the container is closed the quantity of material in the system is invariant no matter what changes in state are involved.

Systems of variable weight (3) are commonly encountered in engineering practice. Figure 2 shows a diagrammatic arrangement descriptive of this case. As before, immersion in a bath offers a means of controlling temperature while changes in the total volume may be accomplished by movement of the pis-





ton A. For discussion the system will be considered to be bounded by the walls of the container and the contents of tube B will not be taken as a part of it. This tube, however, provides a means of adding material to the system or withdrawing a part of it, thus varying the weight of material within the container. In this way, not only can the intensive properties of the system be changed by manipulation of the pressure, temperature and total volume, but also the weight of ulation of the pressure, temperature varied by addition or removal of matter through tube B.

If the total volume of the system is made invariant by fixing the position of the piston A and material is introduced into the chamber, the state of the system is changed. This becomes apparent from consideration of the following equation:

(1)

$$V=\frac{\underline{V}}{m}$$

Since the total volume of the system V has remained unchanged, the specific volume must undergo a variation which is inversely proportional to the change in the weight of the system. If the temperature of the system was maintained at a constant value during this process it immediately becomes possible to represent the specific volume of the material in the system as a function of the weight. This is depicted in Figure 3 for the conditional restraints that the total volume of the system and the temperature have remained invariant during the change in weight. Similarly the pressure may be portrayed as a function of the weight if the relationship between the specific volume and pressure is known. If it is assumed as a special case that this relationship may be expressed by the perfect gas laws it is summarized in the following expression:

$$P=bT/V$$

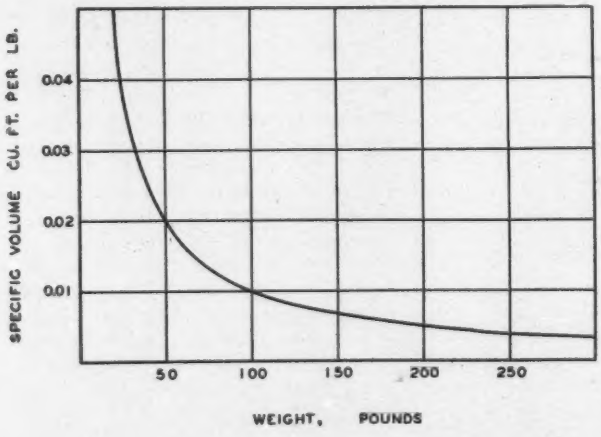
This equation may be combined with Equation 1 to give:

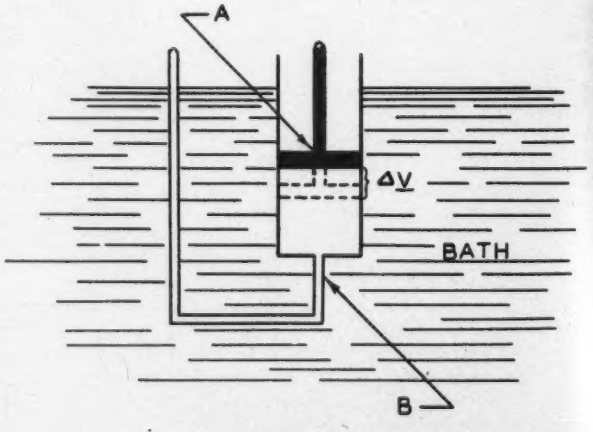
(3)

$$P=\frac{bTm}{\underline{V}}$$

Equation 3 indicates that for the particular case of a perfect gas there is a linear change in pressure with the weight of the material added under the conditional restraints that the total volume of the system and the temperature remain unchanged during the addition process. This behavior is indicated in Figure 4. It should be emphasized at this time that the simple relationships indicated in Figure 3 result only in case of applicability of the perfect gas laws.

Instead of stipulating constancy of the total volume and the temperature of the system, the temperature and pressure might be maintained invariant during a change in weight of a system. Under these circumstances the piston A of Figure 2 would be moved so as to maintain the pressure constant while the bath in which the system is immersed would be maintained at a fixed temperature. The change would then constitute an isobaric, isothermal process. If the behavior of a pure substance is considered first, the process may be analyzed in the following fashion. The introduction of a unit weight—for example, one pound—of the material into the system results in an increase in its total volume of an amount $\Delta\underline{V}$, as is indicated in Figure 4.





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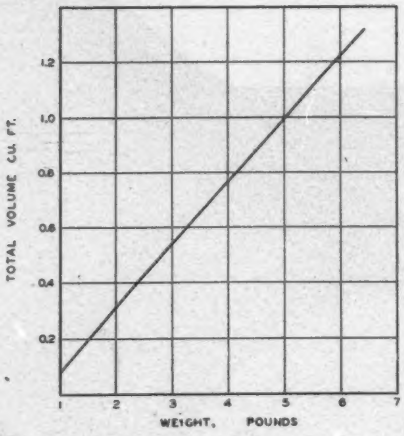


Figure 5

In the case of a homogeneous one-component system, for which the specific volume is constant when the pressure and temperature are fixed, the magnitude of this increase in the total volume of the system may be readily ascertained by differentiation of Equation 1 to yield:

(4)

$$d\underline{V} = V dm$$

Integration of this equation gives:

(5)

$$\Delta\underline{V} = V \Delta m$$

It follows, therefore, in the case of a pure substance that there is a linear relationship between the total volume and the weight as long as the temperature and pressure remain invariant. This fact is in no way related to any equation of state for the material in question.

In the case of a multicomponent system the situation is somewhat more complex but the essential principles remain unchanged. The introduction of a unit weight of a material having the same composition as that of the system as a whole results in no change in the specific volume of the system. Therefore Equation 4 remains applicable and the linear relation between the weight and the total volume of the system obtains. If, instead of adding material of the same composition as that of the system, a certain amount of one of the components were added, the weight of all the other components remaining unchanged, the specific volume could no longer be expected to remain constant and a more detailed consideration becomes necessary.

The stipulation of the pressure and temperature, and of the weight of each of the components present is sufficient to define completely the state of the system. Therefore, the total volume is a single-valued function of these variables. This fact may be indicated by the following expression:

(6)

$$\underline{V} = f(T, P, m_1, m_2, \ldots, m_n,)$$

From this relation it follows that a change in the total volume of the system may result from a variation in any one of these quantities. For the particular situation in question when the pressure, temperature, and weight of all of the components but one are maintained constant there is only one quantity left for variation; namely, the weight of that one component, which will be designated as component k. Under these conditions it follows that the variation in the total volume of the system may be expressed in terms of the weight of component k added and of the rate of change of total volume with increase in the weight of the system upon addition of compoonent k under the specified conditions. The resulting relation is

(7)

$$d\underline{V} = (\delta\underline{V}/\delta m)_{T,P,m_1} dm_k = \overline{V}_k dm_k$$

The quantity $\overline{V}_k$ is called the partial volume of component k and it is defined by the second equality of Equation 7, which may be rewritten for the purpose as,

(8)

$$\overline{V}_k = (\delta\underline{V}/\delta m_k)_{T,P,m_1}$$

G. N. Lewis originally proposed the concept of "partial" quantities (1) in connection with a system of thermodynamics and he made widespread use of it in connection with relations for systems of variable weight which had earlier been treated by Gibbs (4).

From a physical point of view it is well to consider the situation indicated in Figure 4 during a process involving the introduction under equilibrium conditions of a quantity of any component which may be called component k for convenience. If the temperature, pressure and the weights of all of the other components are fixed, the total volume is a single-valued function of the weight of compound k present. The influence of the weight of component k on the total volume of the system under these conditions is portrayed in Figure 5. In contrast to the situation indicated for a pure substance, in which there is a linear relationship between the total volume of the system and its weight, the relationship shown in Figure 5 is non-linear although the deviation is not large. At point A corresponding to zero weight of component k the relationship between the total volume and (m_k) may be somewhat complex. In fact, in some instances involving solutions of electrolytes, addition of a small amount of the component in question may actually result in a decrease in the total volume of the system. Fortunately, this is not the case for hydrocarbons although rather marked curvature is indicated. As the quantity of component k increases the relationships become simpler and when the system becomes almost entirely made up of component k the relationship becomes linear, as in the case of a pure substance. Under these circumstances the process involves only the addition of pure component k to a system made up wholly of this material.

A consideration of Equation 8 indicates that the slope of the curve of Fig. 5 at any point represents the value of the partial volume at that point since the slope of the curve is the rate of change of the total volume of the system with respect to change of the weight of component k under conditions of constant pressure, temperature, and weight of each of the other components. For example, the partial volume of component k at point A may be established by drawing a tangent to the curve at this point and ascertaining the slope of this line as is indicated by the following expression:

(9)

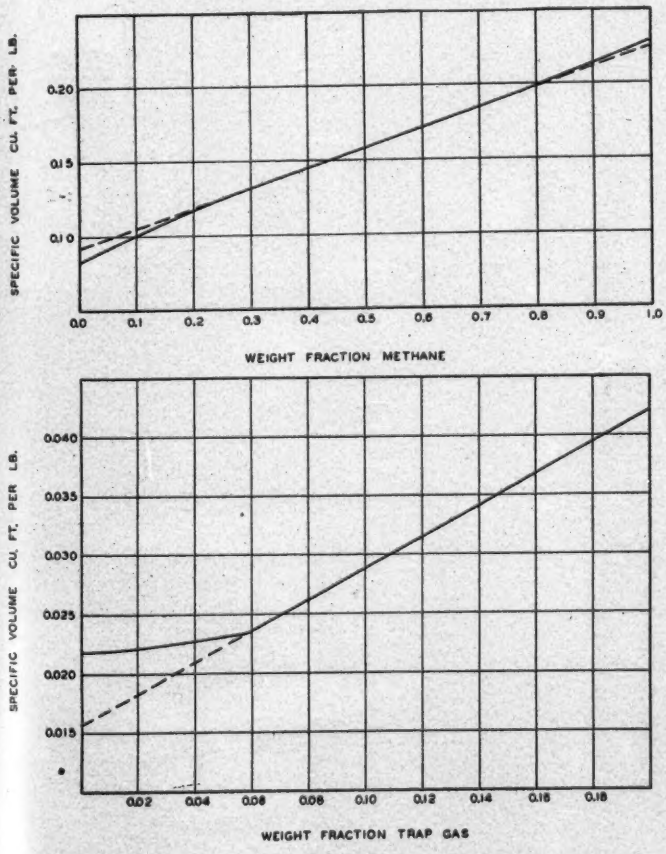
$$\overline{V}_k = (\delta\underline{V}/\delta m_k)_{T,P,m_1} = \left[\frac{\Delta\underline{V}}{\Delta m_k}\right]_{\text{tangent}}$$

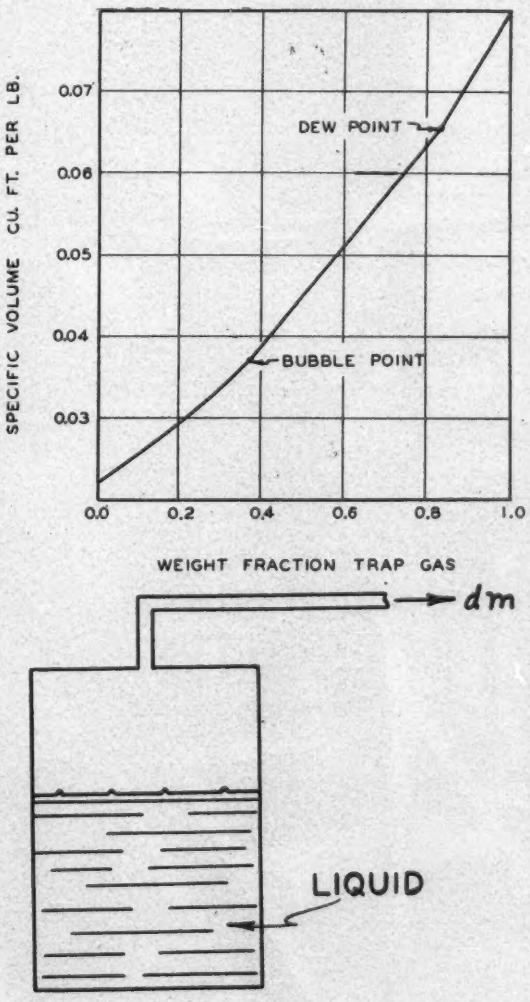
Equation 9 affords a means of establishing the partial volume of a component if the information indicated in Figure 5 is available. This is not always the case since experimental data relative to the behavior of multicomponent systems are usually presented as values of the specific volume as a function of pressure, temperature, and composition. Roozeboom (5) proposed a graphical method for the evaluation of partial volume from such data. The specific volume of a gaseous mixture of methane and ethane (6) is shown as a function of the weight fraction of ethane at a pressure of 2,000 pounds per square inch and temperature of 250°F. It is apparent that these two gases do not form ideal solutions (7) under these circumstances since the specific volume is not linear

with respect to composition at constant temperature and pressure. It can be shown (8) that the intercepts of a tangent to such a curve with each of the composition axes correspond to the partial volumes of the respective components. For example, a tangent to the curve has been indicated in Figure 6 for a composition corresponding to approximately 0.6 weight fraction methane. This tangent intersects the methane composition axis at a value of 0.226 cubic feet per pound and the ethane axis at a value of 0.0910 cubic feet per pound. These two values are the partial volumes of methane and ethane, respectively, in the methane-ethane system (6) at 2,000 pounds per square inch and 250°F. This procedure affords a simple and useful means of determining the partial volume of a component.

The foregoing example represents an application of this method to a binary system. Is may be employed for a multicomponent system equally well if the specific volume of the system is known as a function of the weight fraction of a component in question, while the relative quantities of the other components are maintained invariant, together with the pressure and temperature. Likewise it is possible to calculate the partial volume of a constituent (9) which consists of several components taken as a group of fixed composition. For example, if particular samples of natural gas and crude oil are considered to be the constituents of a multicomponent system of restricted composition, the partial volumes of these constituents may be established in the following way: The specific volumes of mixtures of the crude oil and natural gas are ascertained at constant pressure and temperature and are plotted as a function of the weight fraction of one of these constituents. An example of such a diagram for a system made up of samples of gas and liquid phases obtained from a high-pressure separator in the Rio Bravo field (10) is presented in Figure 7. In this instance the particular choice of pressure and temperature involved results in the existence of the system in the liquid, two-phase and gaseous regions as composition is progressively changed. However, the experimental information was insufficient to ascertain with certainty the location of the dew-point and it has not been indicated in Figure 7. As a matter of illustration, a tangent to this curve has been indicated at a weight fraction of trap gas of approximately 0.1. The intercepts of this tangent with the composition axis corresponding to the trap liquid represents the partial volume of this constituent while the corresponding intersection with the composition axis corresponding to trap gas is the partial volume of the latter constituent. Physically, the partial volume of the trap liquid at this state represents the rate of change in the total volume of the system necessary to maintain the system at constant pressure and temperature during the addition of this material.

(To Be Continued)





Left, above, Figure 6; below, figure 7. Right, above, Figure 8; below, Figure 9.

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Horsepower

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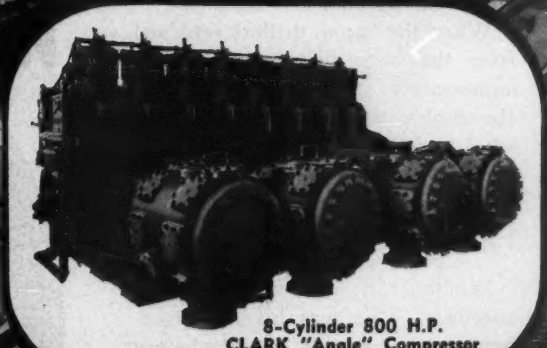

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THIS LAUGH

OFF!!

And now, with the deer season just finished and the Nimrods on the return, we recall **Ray Humphrey's** story of the three drillers who went hunting.

Some one had to take care of the camp, cook, and otherwise suffer, while the other two sought the elusive deer. Lots were drawn, and it was decided that the first hunter who complained about the food or camp arrangements should promptly take the place of the camp drudge, until further complaints brought other substitutions.

The driller who drew the short straw worked diligently at his camp duties for a week, and the two hunters were careful not to voice complaints. By the time the second week of drudgery was coming to a close, the unfortunate cook was becoming desperate. He was going to hear complaints or know the reason why. With this as his objective he garnished the evening meal with materials most g e n e r a l l y found where cattle roam the dales.

When the happy drillers returned from the hunt that evening, they immediately sat themselves before the cook's offerings. The driller who took the first bite promptly sprang to his feet with: "Great gosh, this tastes like, like, ah, but it's good, yes, very good!"

Sambo had been arrested for speeding. This was his fourth offense, and as he was brought before the Judge, he muttered something under his breath. It sounded suspiciously like an oath.

"Repeat that!" thundered the Judge.

"Ah didn't say nothing," begged Sambo.

"You did say something and I want you to repeat it."

"All ah says was 'God am de jedge; God am de jedge'!"

The visitor paid his green fee, fixed up a match and went to the first tee. Taking his stance, he gave a wild swing and missed completely.

"By George!" he said to his opponent. "It's a good thing that I found out early in the game that this course is at least two inches lower than the one I am used to playing on."

Two Hibernians arranged to fight a duel with pistols. One of them was very fat, and when he saw his lean adversary facing him, he raised an objection.

"Begorra!" he said, "I'm twice as big a target as he is, so I ought to stand twice as far away from him as he is from me."

"Be aisy now," replied his second. "I'll put that right, immediately."

Taking a piece of chalk from his pocket he drew two lines down the fat man's coat, leaving a space between them.

"Now," he said, turning to the other man, "fire away, ye spalpeen, and remember that any hits outside that chalk line don't count."

When you have to tighten up your belt, it's a recession. When you have no belt to tighten, it's a depression, and when you have no pants, it's a panic.

Perry Kilsby tells about the Los Angeles girl who visited her boy friend at Camp Lewis, Washington, over the week-end. It seems she flew up Friday night and flew back Sunday but she hasn't flown since.

Names used on this page are entirely fictitious, and any resemblance to persons either living or dead is purely coincidental.

WEIGHT INDICATOR POINTS
IT STANDS TO REASON that Martin-Decker doesn't build tool-pusher model weight indicators and mud gauges just to be making them. They have a valuable place in many oil field operations.
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Field Development

Los Angeles Basin

Four to Complete At Wilmington-Torrance

Within a few hours of each other, four wells will be completed in the Wilmington-Torrance area in the next week. At this writing all four are standing cemented with 8⅝ in. casing set above the Terminal zone at depths ranging from 3095 to 3227 ft. depending on structural location. Operators of the wells are Bristol Oil Corp., Los Angeles Basin Petroleum Corp., Los Feliz Oil Co. and Westport Oil Co. New locations have been surveyed by D. D. Dunlap Trust, Los Feliz Oil Co., Silver Petroleum Co., Westport Oil Co. and Wilforth Oil Co.

Getty Well Nears Athens Deep Zone

J. Paul Getty's Athens No. 2-12, Getty-4, located at the corner of 124th St. and Hoover St., is now below 7500 ft. and will soon core for the O'Dea sand which is expected near the 7800 ft. level.

In the Rosecrans section of the Athens-Rosecrans field, Barnsdall Oil Co. is running two strings of tools, Trust No. 7 drilling at 3000 ft. and O'Dea No. 21 below 7300 ft. The Trust well may be carried to the 9000 ft. zone.

Hellman Completes Seal Beach Well

The Hellman Estate Co., operating on fee land at the east end of Seal Beach, brought in No. 12 from the Lower Wassem zone at 5618 ft. flowing 1040 bbls. of 30 gravity clean oil daily through a restricted orifice. Beaned back to 16/64 in., production was 831 bbls. per day under 700 lbs. flow pressure.

Marfar Completing Five Points Well

Marfar Oil Co., headed by John Marion, is completing its first Huntington Beach Five Points well, Greer No. 1, after landing a 5½-in. combination string at 4240 ft. The well is located in the small pool south and east of the intersection of Huntington Beach Blvd. and Ellis streets.

On the old Union Oil Co. Brooks lease, Harold C. Morton completed No. 5 with 100 ft. open to bottom at 3939 ft. pumping 105 bbls. a day cutting 5.0%. In the northwest area, Signal Oil & Gas Co. finished Signal-Bolsa No. 31-A at 4238 ft. for over 500 bbls. a day and No. 31-B for 356 bbls. from 2690 ft.

Southwest Exploration Co. State

LOS ANGELES BASIN WILDCATS

Area	Well	No.	Section	Depth	Status
Athens	Rankin & Williams	1	7, 3-13	9483	Idle
Castaic	O'Dell, A. J.	1	9, 4-17		Location
	Young, Roy, W., Inc., Walker	1	11, 4-16	6266	Drilling
	The Texas Co., Fernando	1	11, 4-17	5615	Drilling
Newhall	Airline Oil Co., Perkins	1	11, 3-16	200	Idle
	Aztec Oil Co., Sanborn	1	6, 3-16	6113	Idle
	Barnsdall Oil Co., Limbocher	1	17, 3-16	4646	Drilling
	Rankin & Norell, Ferguson	1	31, 4-16		Rig
	Willis & Assoc., Ferguson	1	30, 6-17		Rigging up
Palos Verdes	Newton Dev. Co., Palos Verdes	1	13, 5-15	4391	Drilling
	Surety Holding Co.	1	22, 5-14	965	Idle
Puente Hills	Axis Pet. Co., Tandberg	1	13, 2-11		Location
	Continental Oil Co., Turnbull Comm.	2	13, 2-11		Location
	Sunset Oil Co., Baldwin	1	11, 2-11	4681	Idle
Rio Hondo	Potrero Oil Co., Well	1	32, 1-11	1940	Drilling
	Imperial Corp., Rolland Lee	1	25, 2-17		Foundation
San Fernando	Shell Oil Co., Mission	2-1	25, 3-16		Rigging up
	Tide Water Assoc., Mission	1	26, 3-16	7391	Drilling
Whittier La Habra	Fullerton Oil Co., La Habra	10	25, 2-11	2780	Completed
	Los Nietos Valley Oil Co., Woodard	1	29, 2-11		Rigging up
	Union Oil Co., Sansinena	13	30, 2-10	2066	Drilling
	Orange County				
Anaheim	The Texas Co., Spencer	1	1, 4-11	3884	Drilling
Bolsa Chica	La Bolsa Ro. Oil Synd., Well	1	22, 5-11		Rig
Costa Mesa	Thompson, Milton N., Banning	1	9, 6-10	5649	Idle
Kraemer	Atlas Oil Co., Kraemer	1	36, 3-9		Grade
	San Bernardino County				
Chino	Prado Oil Corp., Lamp	1	32, 2-7	1733	Idle

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No. 4, a tideland well bottomed at 4990 ft., came in for 500 bbls., clean and Standard Oil Co. brought in Bolsa No. 2, after a redrill job, pumping 200 bbls. a day.

Next well scheduled for completion is West American Oil Co.'s Ashton No. 9 which is below 4000 ft. and will soon be ready to set casing.

Tide Water Tests Inglewood Well

In order to determine the productivity of the upper portion of the deep zone, Tide Water Associated Oil Co. stopped drilling Vickers No. 72 at 8190 ft. and ran a formation tester setting the packer at 7753 ft. Fluid reached the surface in a short time and flowed for an hour and a half at a 760 bbl. a day rate, the cut cleaning up in that time to less than 4.0%. The gas flow was measured at a 3,200,000 cu. ft. rate. Now deepened to 8320 ft., the hole is being conditioned to run a liner for final completion.

Hogan Petroleum Co.'s Machado No. 4A is drilling below 7000 ft. while Jergins Oil Co. is preparing to build a rig for Howard No. 3 and The Texas Co. is redrilling R. C. Smith No. 8.

Atlas To Drill Kraemer Well

The recently organized Atlas Oil Co. has acquired a lease on a portion of the Kraemer property in sec. 36,3s-9w adjoining the East Richfield field and is planning to drill in the immediate future.

Oak Canyon Well Sets Water String

Western Gulf Oil Co. is preparing to complete Wickham No. 1 at Oak Canyon by gun perforating 7 in. casing cemented on bottom at 7437 ft. The well topped oil sands at 7272 ft. similar to those productive in Lechler No. 2 nearly half a mile to the north. Little information is yet available on correlations between the three deep wells in the area but tentative figures place Wickham No. 1 approximately 71 ft. higher

in other words
by JOHN CLINTON

Do you remember the first auto your folks had? Maybe it was a sedate old *Rambler* or a spunky *Flanders*, with brass radiator, carbide lights and a bulb-squeeze horn like a duck with a sore throat. Those were the days of *tall* autos. On a clear day you could see Catalina from the driver's seat.

* * *

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* * *

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* * *

Get Triton from the Union Minute Men wherever you see the sign of the big orange and blue 76. Try it and just see for yourself.

than Lechler No. 2 and more than 1000 ft. higher than Hathaway Co.'s Ram No. 2 half a mile west. These correlations are subject to revision as more data become available on markers definitely pegged in each of the three wells.

The deep zone was not considered worthy of testing in Hathaway's Ram No. 2 and an attempt is now being made to complete in the Lechler No. 1 zone at 2725 ft.

Western Gulf Oil Co. has derrick up for Lechler No. 3 just north of a line between Nos. 2 and 1. Development at Oak Canyon has, so far been confined to sec. 31,5n-17w with Western Gulf operating in the east half of the section and Hathaway Co. working in the northeast quarter of the southwest quarter.

Signal Hill Well Pumps 111 Bbls. a Day

Finishing Nesa No. 14 at 3630 ft. with a liner perforated at intervals below the shoe of the water string at 2970 ft., Shell Oil Co. obtained 111 bbls. of clean oil a day. This is considered a very good yield for the old central section of Signal Hill, the well being located approximately 900 ft. east of the intersection of Cherry Ave. and Hill St.

Montebello Well Cores Shallow Zones

Brookner Oil Co.'s well at the intersection of Lincoln Ave. and Avenida de la Merced on the south flank of the old Montebello field is coring for the Second Zone at 4025 ft. after finding rather depleted looking oil sand in the First Zone topped at 3620 ft.

Union Drilling Sansinena No. 13

In an effort to extend to the east the small new field discovered by Fullerton Oil Co. along the Whittier Fault, Union Oil Co. is drilling Sansinena No. 13 in sec. 30, 2s-10w. The new well offsets the La Habra lease in sec. 25, 2s-11w on which Fullerton Oil Co. has completed several good shallow producers in the past year.

Continental Starts New Turnbull Well

With Turnbull Community No. 1 pumping steadily at a 235-bbl. rate of 23 gravity oil and about 100 bbls. of water, Continental Oil Co. is clearing orange trees from the site for No. 2. The second project is to be drilled 350 ft. west of the discovery well using Continental's new portable outfit.

Three quarters of a mile northwest along the same structure, Axis Petroleum Co. is preparing to drill on the Tandberg property at the insection of Turnbull Canyon Road and La Mesita Drive. Following the completion of Continental Oil Co.'s No. 2, J. Paul Getty is expected to drill his small fee property in the center of the Continental lease block.

After perforating and testing various intervals from the 4681 ft.

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bottom back to 3500 ft., Sunset Co. suspended operations in Baldwin No. 1 which was seeking another accumulation west of the Turnbull Canyon play.

Two Wells Active In Newhall Area

Two wells are active at the present time in the Newhall area. In Towsley Canyon, the combined operators, Barnsdall Oil Co., Bandini Petroleum Co. and Ambassador Petroleum Co., are drilling in hard shale at 4650 ft. with the formation still showing very steep dips. South and east of the Newhall-Potrero field, C. G. Willis and Associates have just spudded in sec. 6, 4n-17w. Work on the latter well is contracted to Kern Drilling Co.

Castaic Wildcat Looks Favorable

Indicating a possible new discovery in the Castaic district, The Texas Co.'s Fernando No. 1 is coring at 5625 ft. in shale with occasional streaks of sand showing oil. The showings, topped at 5475 ft., appear to be in the lower section of the Pliocene and may be considered a fair indication that commercial sands will be encountered in the top of the Miocene which should soon be entered. The Texas well is located in sec. 11, 4n17w in Hasley canyon north and east of the Del Valle field.

Six miles due east, Roy Young, Inc. is drilling Walker No. 1 below 6300 ft. in sec. 11, 4n-16w.

Del Valle Outpost Finds Sherman Wet

R. E. Havenstrite's Liebhart No. 1, easterly Del Valle outpost, is coring for the lower zones after a formation test of the Sherman Sand interval 5870-5970 ft. recovered eight stands of oil and 50 stands of salt water. The Havenstrite interests are drilling Lincoln No. 9 below 3200 ft., and are rigging up No. 10.

In the westerly section of the field, Standard Oil Co., Ohio Oil Co. and Herley-Kelley are drilling wells, all at relatively shallow depths.

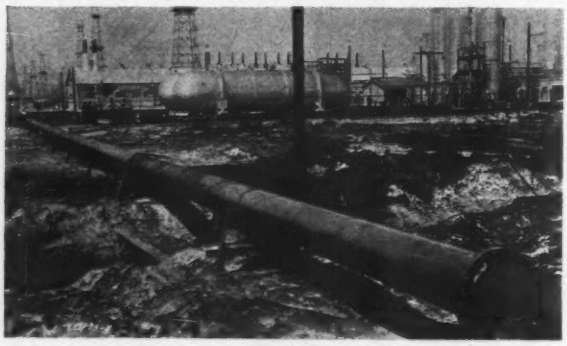
Deep Test Proposed For West Dominguez

Finding the Seventh Callender zone non-commercial, Decker-Osborne & Associates are preparing to carry Froom No. 1 to 9000 ft. if necessary to uncover new production in the extreme southwest portion of the Dominguez field. Seven inch casing is set at 7247 ft. and it is planned to deepen from present bottom at 7268 ft.

Latest completion in the west Dominguez area is Union Oil Co.'s Austin No. 8 which bottomed at 7125 ft. and came in for 601 bbls. of 31.7 gravity clean oil.

The Texas Co. Drills Buena Park Wildcat

With bottom now below 4000 ft., The Texas Co. is drilling Spence No. 1 in sec. 1, 4s-11w between Buena Park and Anaheim.



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Seaboard Completes Second at Raisin City

Flowing initially 237 bbls. a day of 25.7 gravity clean oil through a 16/64 in. bean, Seaboard Oil Corp., Tide Water Associated Oil Co. and Union Oil Co. brought in their second joint project at Raisin City. No. 77-13, one location northwest of their first well offsetting Shell Oil Co.'s discovery property, appears to be the highest structurally of any yet drilled in the new field having topped the high pressure gas sand at 4975 ft. and the Shell sand at 5006 ft. Only the lower sands are open, however, the liner being perforated in a five foot interval at 5100 ft. and 10 ft. above bottom at 5132 ft. Indicating a high potential, flow pressure on the first test exceeded 800 lbs. per square inch and casing pressure built up as high as 1375 lbs. Gas production approximated 150,000 cu. ft. After one day the well was shut in with pressures of 1030 lbs. on the tubing and 1750 lbs. on the casing head.

Moving to the northwest, the combined operators will next drill No. 66-13 for which derrick is already erected 660 ft. north and 660 ft. west of No. 77-13. No. 88-13, the syndicate's first effort, was last reported flowing 170 bbls. of 24 gravity oil cutting 11.0% and 50,000 cu. ft. of gas through an 11/64 in. bean. All three of these wells are located in the southeast quarter of sec. 13,15s-17e.

Possibly indicating limits of the field may soon be reached in an easterly direction, Shell Oil Co.'s No. 31-19 on the Santa Ana & Fresno Land Co. property in sec. 19,15s-18e was completed in the two upper oil sands flowing 214 bbls. a day cutting 11.0% on gas lift. This is the first well failing to come in flowing naturally and the first to show so high an initial cut. There is, however, a possibility that other considerations may be involved.

Shell Oil Co. is moving its drilling equipment back to the Properties, Inc. lease where No. 7-18 is being prepared to spud.

In an attempt to extend the producing area to the southwest, Barnsdall Oil Co. is drilling Ripperdan No. 1 in sec. 24, 15s-17e.

Amerada to Drill New Helm Project

Seeking to extend production half a mile to the northwest of the discovery well, Clover No. 31-34 in sec. 34,16s-17e, Amerada Petroleum Corp. is preparing to drill Wyant No. 5-27 near the west quarter corner of sec. 27,16s-17e.

The Clover well, now shut in, found large volumes of gas and high gravity condensate in two intervals of the Miocene from 7303 to 7313 ft. and from 7448 to 7465 ft. and in the Eocene from 7990 to 8005 ft. Only short tests were made of the lower sands, just enough to prove commercial rates in each, but on a longer trial, the upper zone yielded gas at a 13,618,000 cu. ft. rate and 64 gravity oil at 662 bbls. a day. This hole drilled to 10,257 ft. topping Cretaceous at 8194 ft. before plugging back for the production test.

Half a mile southwest of Clover No. 31-34, General Petroleum Corp. is pouring foundations for Esperoad No. 75-33 in sec. 33,16s-17e. The correlation of markers from the three wells will shed light on the

SAN JOAQUIN VALLEY WILDCATS

Area	Well	No.	Section	Depth	Status
	Fresno County				
Helm	Amerada Pet. Co., Wyant	5-27	27, 16-17		Foundation
	General Pet. Corp., Esperoad	75-33	33, 16-17		Grade
Jacalitos Hills	Wilshire Annex Oil Co.	21-26E	26, 3-15		Rigging up
Raisin City	Barnsdall Oil Co., Ripperdan	1	24, 15-17	980	Drilling
	Seaboard-T.W.A.-Union, S.T.U.	66-13	13, 15-17		Rig
	Seaboard-T.W.A.-Union, S.T.U.	77-13	13, 15-17	5132	Completed
	Shell Oil Co., Inc., Prop. Inc.	7-18	18, 15-18		Foundation
	Santa Ana & Fresno Land, Prop. Inc.	31-19	19, 15-18	5077	Completed
Riverdale	Amerada Pet. Corp., Lawton	45-26	26, 17-19	7878	Drilling
	Kern County				
Arvin	Pacific Western, Geo. F. Getty, Inc. Houchin	1	27, 31-29		Grade
Belridge—South	Section 27 Oil Co., Aslin	1	27, 28-22	1390	Idle
	Ivy Drilling Co., Parkford	1	12, 29-21	1140	Testing
	Sentinel Oil Co.	1	10, 28-20	3902	Idle
Devils Den	Morton, H. C., Core Hole	1	30, 26-19	2220	Pumping
Edison	Getty, J. Paul, Portals Corp.	1	5, 30-29		Rig
Grapevine	Kern Line Oil Co.	1	19, 11-19	8390	Idle
Kern Front	Richfield Oil Corp., Kramer	1	34, 28-27	7738	Abandoned
McClung	Macrate, A. N., Haberfelde	1	32, 29-26	11595	Drilling
Mt. Poso	Alpha Oil Co., C. V. Elliott	1	1, 27-28	1027	Drilling
	Bishop, Bradford	1	22, 27-28	1432	Testing
Paloma	Western Gulf Oil Co., Symons	12-7	7, 32-27	11656	Drilling
Richgrove	Bolling, R. S. Quinn	3	15, 25-27	460	Drilling
	Shell Oil Co., Smith Cairns	3	11, 26-27		Foundation
Shafter	Continental Oil Co., KCL	C-2	35, 27-24	12934	Completed
	Continental Oil Co., Lachenmaier	1	36, 27-24		Rig
	General Pet. Corp., S.P.	51-15	15, 28-24	12602	Drilling
Shale Hills	The Texas Co., Anderson, Inc.	1	19, 28-20	5719	Drilling
	Tideland Oil Co., Grant Est.	1	4, 27-18	1325	Drilling
Union Avenue	Hancock Oil Co., Roberts	3	6, 30-28	4241	Drilling
	Kings County				
Kettleman Hills	Mid-Kettleman Co., Bunting	1	25, 23-18	9138	Idle
	Tulare County				
Kingsburg	Goble, W. E., Goble	1	28, 16-23	1063	Drilling
Terra Bella	Stout, Geo. W., Stout	2	11, 23-27	745	Pumping
Trico	Trico Oil & Gas Co., Seymour-Bolz	1	20, 24-23		Rigging up

form and extent of the structure as well as furnishing additional reservoir data.

Wilshire Annex Starts Second Jacalitos Test

Wilshire Annex Oil Co. is preparing to spud its second well in the Jacalitos Hills approximately 1320 ft. north and 660 ft. west of No. 33-26E which discovered Temblor production near the center of sec. 26,21s-15e. With only 20 ft. open from 3885 to 3905 ft., the discovery well was completed on the pump last month for 100 bbls. a day of 40 gravity clean oil to bring in another shallow Fresno county field.

Kern Front Try Quits in Granite

Richfield Oil Corps. exploratory Kraemer No. 1, located a mile south of the Kern Front field in sec. 34, 28-27, is abandoned at 7738 ft. after finding the granite basement at 7724 ft. Top of the barren Vedder was 6200 ft. and the Eocene was placed near 7200 ft.

Drilled with the expectancy of either completely examining the section or finding production at the outpost location, the test found no showings above the granite.

Paloma Outpost Looking Ahead

A mile east of present Paloma production, Western Gulf Oil Co. is drilling ahead in hard shale at 11,656 ft. in Symons No. 12-7. Located in the northeast corner of sec. 7, 32-27, the current driller cored light, condensate type oil sand from 11,270 to 11,547 ft. which appeared capable of production comparable to that of the main body of the field.

The try had previously cored light oil sand in the interval 10,939 to 10,990 ft. and hard sandstone showing oil in the next five feet.

With even the first sands nearly 700 ft. lower on structure than first showings within the field, the well is obviously low, but nothing has been encountered which would indicate other than a successful addition to Paloma field limits.

Macrate Wildcat Yet Above Vedder

A. N. Macrate & Sons Haberfelde No. 1, Vedder try near the center of sec. 32, 29-26 a mile and a half south of Greeley production, is fishing drill pipe after reaching 11,595 ft. in hard shale. Top of the Olcese was placed at 11,180 ft. and subsurface men have indicated that the objective horizon may be expected near 11,900 ft.

The test had been conceded a chance at Stevens zone production, also produced in the Greeley field, but the zone was barren at 8090 ft.

Pac. Western-Geo. F. Getty To Drill Arvin Outpost

Pacific Western Oil Co. and Geo. F. Getty, Inc. have graded location for Houchin No. 1 in the northeast corner of sec. 27, 31-29 a little more than a mile southeast of the Arvin field.

Located on lands of Houchin Farms, Inc. the well is adjacent to the old Wood-Callahan Houchin No. 1 near the north quarter corner of the northeast quarter of the section. This well was drilled in 1937 by the General Petroleum Corp. and was finished flowing 120 bbls. of clean 29.7 gravity oil.

Stout Gets Small Terra Bella Pumper

Geo. W. Stout finished Stout No. 2 in sec. 11, 23-27 in the Terra Bella area of Tulare county pumping an estimated 10 bbls. of 16.0 gravity oil cutting 82.0% from 745 ft.

Shallow Devils Den Activity Continues

The flurry of shallow drilling and small pumping completions in the Devils Den area continues at a rapid pace. In sec. 26, 25-18, E & S

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Oil Co. is drilling well No. 1 at 810 ft. Raymond D. Herzog is at present operating four strings at shallow depth in sections 24, 26 and 27 of the township and is pumping three new wells for an average 8 bbls. of 20 gravity oil daily from a little more than the 200 ft. level.

R. S. Meisse finished Jacqueline No. 3 in sec 26, 25-18 from 468 ft. for 7 bbls. of clean oil and is preparing to drill No. 4. Meisse & Emerich is drilling Margaret Smith No. 2 at 285 ft. in shale in the same section.

South of the area, in sec. 30, 26-19 of what is more properly identified as the Blackwells Corner area, H. C. Morton finished Core Hole No. 1 from plugged depth of 1000 ft. pumping 50 bbls. of 13.5 gravity oil cutting 5.0% daily. Last production was reported as 36 bbls. daily.

Amerada Explores Riverdale District

Amerada Petroleum Corp. Lawton No. 45-26, located near the center of sec. 26, 17s-19e near Riverdale, is drilling below 7900 ft. At 7600 ft. the drill was reported in shale believed to be the Kreyenhagen equivalent.

Continental Starts New Shafter Project

Moving over into sec. 36, 27s-24e, Continental Oil Co. is preparing to drill Lachenmaier No. 1 to the 12,900 ft. sand from which No. C-2 in sec. 35 is flowing 75 bbls. a day of 37 gravity oil cutting 10.0%.

Three miles southwest of the Continental play, General Petroleum Corp. is coring for the Vedder sands below 12,610 ft. in S.P. No. 51-15, sec. 15, 28s-24e.

Hancock Testing At Union Avenue

With bottom at 4241 ft. and casing cemented at 4206 ft., Hancock Oil Co. is testing its Roberts No. 3 in sec. 6, 30s-28e near Union Avenue south of Bakersfield. The well is said to have cored sufficient oil sand to assure production.

J. P. Getty to Drill Edison Area Wildcat

J. Paul Getty's re-entry into California activity as an individual operator will embrace an Edison area wildcat in the southwest corner of sec. 5, 30-29.

Known as Portals Corp. No. 1, the try, for which rig has already been built, lies a little more than a half mile south of the small production which Francis O'Reilly last effected in the northwest corner of the section.

Mr. Getty is also drilling a deep zone well in the old Athens field of the Los Angeles Basin.

Bolling in New Jasmine Area Try

Again attempting production on the Quinn Ranch holdings in the Jasmine area, R. S. Bolling is drilling Quinn No. 3 at 460 ft. in the southwest quarter of sec. 15, 25-27.

In sec. 11, 26-27 Shell Oil Co. has poured foundation for Smith Cairns No. 3. No. 2 failed to find the production brought in by Smith No. 56-x-11 and was abandoned.

A.I.M.E. to Stage Pan-American Meet

The Southern California Section of the American Institute of Mining and Metallurgical Engineers will have a dinner meeting in the famous La Golondrina Cafe on picturesque Olivera Street, Wednesday evening, December 3rd. An interesting program has been arranged with the charming Senora de Bonza as hostess. Cuisine and entertainment will be typically Latin American.

Mining operations and Latin American relations will be discussed by Clarence Woods who has recently returned to this country after 18 years experience as a mine owner and operator in Peru. Commander V. H. Wilhelm, retiring chairman of the Southern California Section of the A. I. M. E., will preside over the meeting and will be assisted by other prominent local members.

Though the entire cafe has been reserved for the meeting, it is requested that those wishing to attend send their reservations as soon as possible to Milton W. Lewis or Walker Clute, 811 West Seventh St., Los Angeles, or telephone VAndike 5583.

American transport planes are being used by the British to carry water to troops operating in desert regions in North Africa and the Near East.

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Coastal District

O. C. Field Drills Casmalia Property

Resuming development of its extensive Casmalia properties, O. C. Field Gasoline Co. is drilling Righetti No. 2 in sec. 13,9-35. The well will be completed in the 1800 ft. 12 gravity oil zone. Dolly Adams Oil Co. is reported planning to drill in the same area.

Standard Completes Cat Canyon Project

With the hole open from 5545 to 6100 ft., Standard Oil Co. is completing Los Flores No. 3 in the new spot of Monterey production west of the West Cat Canyon field. Standard is preparing to drill No. 4 on the same property and Union Oil Co. is rigging up Bell No. 12. To the east at the north end of the old field, Alphonzo E. Bell Corp. is sidetracking a fish in Gilmore No. 1.

Hopland Company Well Cores Fractured Shale

Hopland Oil Co.'s well No. 1, located on Oakridge Anticline in sec. 1,3n-19w east of Bardsdale, was last reported coring fractured shale at 4622 ft. An electric log, run at 4475 ft., was said to have indicated a shallow zone at 1500 ft. which may be tested if deeper oil sands are not penetrated.

Shell Oil Locates Santa Paula Wildcat

Shell Oil Co. is preparing to drill Santa Paula Saticoy No. 1 in the Santa Clara River valley southwest of Santa Paula in sec. 21, 3n-21w. The well is to be a deep test based on seismograph data.

John Alford Plans Sespe Creek Wildcat

John Alford, Long Beach operator, is reported to have taken over the McCaslin holdings in sec. 19,-4n-19w along Sespe Creek and to be planning to drill in the near future. The new well will be approximately 400 ft. northwest of McCaslin's Burson No. 1 which is idle at 2039 ft.

Three New Wildcats For Santa Barbara Co.

With the defense program creating large new markets for heavier crudes, exploration in Santa Barbara county is steadily gaining in impetus, three important new projects having been announced during the past fortnight.

First of the trio to get under way is that of John W. Lee, Trustee, who is spudding Title Guarantee No. 1 near the west quarter corner of sec. 33,10-33 a mile southeast of present development in the Santa Maria Valley field. A new fault controlled field is sought in the Monterey Chert zone.

Next to start was Royalty Service Corp.'s Careaga No. 1, derrick for which has been completed on a portion of the large Careaga holdings in sec. 8-8-33. This well also has the Monterey as its objective. Small amounts of oil were produced in the nearby Arnold and Douglas-Stratton wells.

Most recent of the group is that of Alphonzo E. Bell Corp., Lompoc No. 6, scheduled as a deep test of the west end of the Lompoc field in sec. 28,8-34. Present plans call for carrying the hole to the Vaqueros which is believed to be present at this locality but has never been tested.

Each of these wells is the result of thorough geological investigation and each is situated in an area considered favorable for accumulation of large quantities of oil.

COASTAL COUNTIES WILDCATS

Area	Well	No.	Section	Depth	Status
Santa Barbara County					
Cat Canyon	Alphonzo E. Bell Corp., Gilmore	1	23, 9-33	6178	Drilling
Careaga	Royalty Service Corp., Careaga	1	8, 8-33		Rig
Casmalia	O. C. Field Gas. Corp., Righetti	2	13, 9-35	785	Drilling
Lompoc	Alphonzo E. Bell Corp., Lompoc	5	29, 8-34	3064	Suspended
	Alphonzo E. Bell Corp., Lompoc	6	28, 8-34		Location
Santa Maria	John W. Lee, Trustee, T.G.	1	33, 10-33		Rig
Ventura County					
Bardsdale	Hopland Oil Co., Well	1	1, 3-19	4622	Drilling
	Ventura Southern Oil Co.	G-1	19, 3-19	225	Drilling
Conejo	Sycamore Oil Co., Boylan	1	23, 1-20	1700	Drilling
Ojai	Oil Prod. Maintenance, Inc., Byhara	1	12, 4-22	1535	Cleaning out
Piru	Pacific Western Oil Co., Temescal	11	4, 4-18		Grading roads
Santa Paula	Shell Oil Co., Inc., S.P.Y.S.	1	21, 3-21		Foundation
Sespe	Ivers, H. A., Kentuck	13½	1, 4-20	865	Idle
South Mountain	Comstock Pet. Co.	1	17, 3-29	2250	Idle
	Loose, E. H., & Dietzmann, J.	1	17, 3-20	4200	Idle
Timber Canyon	Denison, A. T., Denison	1	13, 4-21	288	Drilling
	Crude Oils, Inc., West	1	19, 4-20	927	Drilling
	Henderson-Ortez Oil Co., O'Leary	1	29, 4-20		Rig

NORTHERN COUNTIES WILDCATS

County	Well	No.	Section	Depth	Status
Alameda	Shell Oil Co., Nissen	1	7, 2s-3e	6381	Drilling
Colusa	Pacific National Pet. Corp.	1	17, 17n-4w		Rig
Madera	Blake, T. E.	2	22, 10s-17e		Foundation
Mendocino	Keyt, N. F.	1	3, 12n-17w	1740	No report
Monterey	Loma Grande Oil Co., Corey	1	23, 24s-10e	3695	Fish D. P.
Sutter	Buttes Oilfields, Inc.	7	3, 15n-1e	300	No report
San Benito	The Texas Co., Carter	1	3, 17s-12e	1842	Drilling
Yuba	Wright, L. G., Cox	1	18, 14n-5e	1802	Drilling

O. C. Field Extends Santa Maria Valley

The completion of Brown No. 1 by O. C. Field Gasoline Co. for an initial of 1200 bbls. a day farther extended the Santa Maria Valley field to the west. Open to production is 280 ft. of Miocene from 5220 to 5500 ft. Gravity of the oil was 17 and the cut less than 10 percent. Offsetting the new well, Union Oil Co. has graded roads for Moretti No. 3-3 and has surveyed locations for Moretti No. 3-4 and Union Sugar No. 13.

Activity continues strong throughout the field with Capital Co., Brain & Kohler, Apex Petroleum Co., the Getty interests, Union Oil Co. and Palm Holding Co. all working on one or more wells. Largest completion in recent weeks was A. N. Macrate & Sons Fernandez No. 4, sec. 26,10n-34w, which was finished at 4575 ft. flowing an estimated 3000 bbl. rate.

C.C.M.O. Co. to Deepen Another Rincon Well

Chanslor - Canfield Midway Oil Co., undismayed by the unfortunate results of its two previous tries, is preparing to deepen Hobson No. C-2 to the deep zone found by No. C-9.

Drilled to 9337 ft., No. C-9 was completed as a 125 bbl. well but on attempting to improve the yield, one thing after another befell the project and now it is plugged to 7681 ft. where it is being tested. Hobson No. C-3 was carried to 10,515 ft. but its history has also been a chronicle of hard luck. It is now being redrilled from 9065 ft.

Costa Mesa Wildcat Makes Drill Pipe Test

With the 5649 ft. hole redrilled to 4330 ft., Milton Thompson's Banning No. 1 at Costa Mesa was given a formation test of the interval below 4200 ft. Recovery was reported as 525 ft. of gassy mud with the tool open 20 minutes.

Oil Field Transportation

(Continued from Page 8)

water tank is a rectangular tank which is mounted on a set of skids. The overall dimensions of this unit are, approximately: 8 ft. wide, 16 ft. long, and 6 ft. high; and the unit weighs approximately 7 tons.

The average cost of moving a boiler plant is $150, and the move takes approximately 4 hours. The equipment consists of two truck cranes, a low-bed semi-trailer, and seven men—the latter including two crane operators, one truck driver, two swampers, one roustabout, and a foreman.

During drilling operations most California wells are cemented two or three times, which formerly required that the transportation department move from 100 to 2,000 sacks of cement. In rainy weather this cement had to be protected from water. However, during the past few years the bulk-cement idea has been developed, and especially built tank bodies on semi-trailers have been installed. These are loaded at a central bulk plant —each trailer being equipped with a screw conveyor which discharges the cement directly into the mixing hopper. The legal capacity of these trailers is 400 sacks of cement, but in an emergency the trailers can be used for 600 sacks.

The moving of the drilling derrick from one location to another left the producing wells without derricks. Therefore, it was necessary either to erect production derricks at each location, or to develop portable pulling masts (or derricks) which would comply with the state law—because these are moved daily, and it is impractical to get permits. The engineer was limited to a gross weight of approximately 68,000 lb—18,000 lb. per axle—widths of 8 ft. and heights of 13 ft., 6 inches.

Equipment for servicing light wells very easily is kept within these limits. However, for the deeper wells two general types of portable derricks are in use in California, one being mounted on a semi-trailer. The semi-trailer type is a 6-wheel gooseneck trailer, equipped with 8¼-in. x 15-in. dual tires, upon which is mounted permanently a structural steel derrick which, in the transporting position, is folded back over the top of the truck and semi-trailer. The first section is hinged at the rear of the trailer. The front end is swung upward, beyond top center, by telescoping hydraulic rams—until the four legs of the derrick, which are equipped with adjusting screws, come in contact with the ground. These adjusting screws, are used for setting the derrick at the proper angle.

During pulling operations none of the load is carried on the trailer. The next section is telescoped upward by winch lines, making a complete final unit of 90 ft. which is good for a loading of 300,000 lbs. The hoisting equipment, including a 12,000 cu. in. engine capable of approximately 190 h.p., is mounted on the semi-trailer.

In the transportation position this equipment is 50 ft. long, 13 ft. high, and 8 ft. wide; and the total weight, including lines, is approximately 65,000 lbs.

The truck-mounted type of derrick is mounted on a six-wheel truck, and it is possible to drive all six wheels. Permanently mounted on this truck is a tubular-constructed derrick which is carried in a horizontal position extending over the top of the truck cab. The back end of the first section of the derrick is hinged at the back of the truck. The front end is raised by a screwed mechanism to beyond top center, until the four bottom legs rest on the ground. These legs are equipped with adjustable screws which permit setting the derrick at the correct angle. The load during pulling operations is taken on the ground.

The second section is telescoped upward with a winch line, making a final complete unit of 90 ft., good for a loading of 200,000 lbs. The pulling mechanism is mounted on the truck, using the truck engine as motive power. This is a 935 cu. in. engine, developing approximately 170 h.p. This unit, in the transportation position, is 57 ft. long, 8 ft. wide, and 10 ft. high — with a gross weight of 70,000 lbs., including lines.

Complete cooperation between the transportation men and the designing engineer should make possible the continued speeding up and loading of the wheel. Some day, in the not too distant future, we hope it will be possible to move complete drilling outfits by kicking in a clutch and driving to the next location.

Presented before the Twenty-second Annual Meeting of the American Petroleum Institute, San Francisco, Calif., Nov. 4, 1941.

Supplement Illustration Copies Available

For the benefit of readers who wish copies suitable for framing or other uses, California Oil World has available extra copies of the colored illustrations used in the supplement accompanying the First Issue November. These are facsimile lithographs of illustrations contained in the first geological reports on California published in 1853 by the United States Government.

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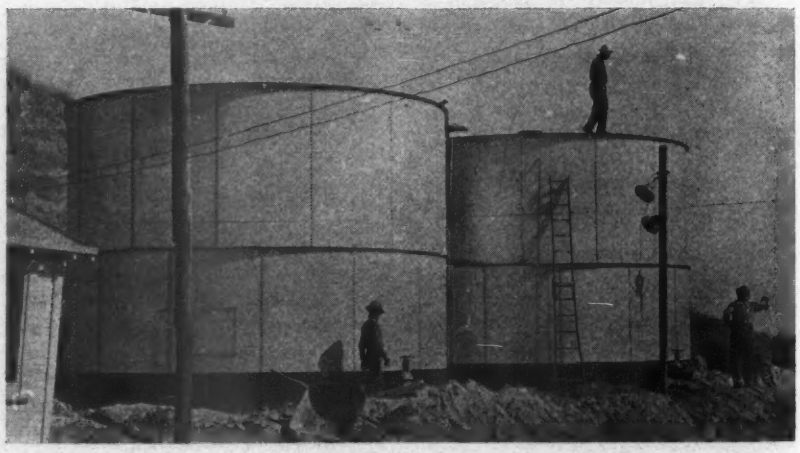
Ickes Says Coordinator Office Is Temporary

Disclaimer that he looks upon his post as petroleum coordinator as anything but a temporary agency, to be discontinued at the end of the emergency was made by Secretary Ickes before a general session of the American Petroleum Institute in San Francisco on November 5. Stating clearly that he has no desire to become an "oil czar" and that the federal government does not want to control the oil industry, the Secretary expressed hope that the industry will be able to continue to manage its internal affairs without undue governmental interference.

In discussing the work of the Coordinator's Office, Mr. Ickes indicated that the cooperative effort of the industry in support of that office in the East Coast oil shortage threat, together with favorable developments abroad, had temporarily relieved the eastern transport problem, and called upon the industry to carry on its efforts, predicting that it may again be necessary to transfer more tankers to British use.

Congressman Cole of Maryland told the A. P. I. session that crude oil requirements of the United States, the British, and their allies can be anticipated at about 5,000,000 barrels daily by the middle of 1943 if the war continues. To meet this demand the federal government must either make available to the industry the necessary pipe and other materials or cut civilian consumption, he stated. Cole predicted that the American public may look for a very definite demand for a curtailment in the use of petroleum and its products.



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